Pennsylvania Aggregate Technician Certification Program

COURSE OUTLINE

2022 Edition

pennsylvania
DEPARTMENT OF TRANSPORTATION

Contents

PENNSYLVANIA AGGREGATE TECHNICIAN

CERTIFICATION PROGRAM

COURSE OUTLINE

I. General Information

A. Objective:

The purpose of this course is to review aggregate testing and general information necessary to qualify as a certified aggregate technician. This course will address the day-to-day testing, record keeping, and quality control requirements necessary for an aggregate to meet PennDOT specifications. This course will address inherent properties of aggregate materials that influence quality test results. It will also review PennDOT specification documents and procedures including actions resulting from quality failures.

B. Course Organization and Presentation:

The course is organized into a two-day program. The first day will consist of a lectures, videos, laboratory tours and hands-on sessions with flat/elongate and gravel crush count along wiht specific gravity and absorption calculations. The second day will consist of additional lectures and calculations on wash loss, gradation and PWL. An open-book test will be given in the afternoon, immediately after lunch, which should be completed by 4 pm. The test will be graded at submission so you will know if you passed the course when you leave. A score of at least 70% is necessary to pass the test.

C. Certification:

NECEPT will certify that you have completed and passed the course and will mail you a certificate within several weeks. Your certification will be registered into the NECEPT program. Certification is for a five-year period. Recertification is explained in Publication 725 “Aggregate Technician Certification Program”. A recertification test will be performed at your site by a DME/DMM representative. The results of the test are pass/fail and the form must accompany your application for recertification. Recertification application can be obtained online at www.superpave.psu.edu.

AGGREGATE
TECHNICIAN CERTIFICATION
PROGRAM

Initial Certification Requirements,
Recertification Requirements
and
Application Procedures

January 2015

Pennsylvania Department of Transportation
Bureau of Project Delivery
Innovation and Support Services Division
Laboratory Testing Section

pennsylvania
DEPARTMENT OF TRANSPORTATION

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I. BACKGROUND

This publication provides information concerning the minimum requirements needed to become a certified aggregate technician performing work for PennDOT. These requirements are part of the Department's technician certification program developed to satisfy the requirements circulated in the Code of Federal Regulations, 23 CFR, Part 637, Quality Assurance (QA) Procedures for Construction, issued June 29, 1995. These Federal Regulations contained the following statement:

> "After June 29, 2000, all sampling and testing data to be used in the acceptance decision or the independent assurance program will be executed by qualified sampling and testing personnel."

In response to this Federal regulation, the Department began development of an aggregate technician certification program in 1997. The program included the certification of aggregate technicians. Continuous improvements have been made to the aggregate technician certification program since 1997. As part of these improvements, the Department agreed upon minimum requirements for initial certification and recertification of aggregate technicians. Each applicant must meet these minimum requirements before they are eligible to become a certified aggregate technician.

This publication includes the minimum requirements for initial certification and recertification and the application procedures for applicants requesting to become certified aggregate technicians as follows:

- Aggregate Technician in Training
- Aggregate Technician

The initial certification and any subsequent recertification period will be five (5) years.

II. AGGREGATE TECHNICIAN IN TRAINING – CERTIFICATION

A. Certification Requirements

1. Applicant must have a minimum of 300 hours of documented work experience under the direct supervision of a PennDOT Certified Aggregate Technician.

2. Applicant must have the signature and the certification number of the PennDOT Certified Aggregate Technician who directly instructed and supervised them for the work experience required above.

3. The District Materials Engineer/ Manager (DME/DMM) or their representative will evaluate the applicant by administering the Aggregate Technician Certification/Re-Certification Test (on page 12). Upon satisfactorily completing the evaluation, the DME/DMM will sign the evaluation form and provide the applicant with the signed original.

4. The DME/DMM is to maintain a copy of the evaluation and forward a copy to:

   PennDOT Aggregate Technician- in-Training Administrator
   Bureau of Project Delivery
   Innovation and Support Services Division
   Laboratory Testing Section
   81 Lab Lane
   Harrisburg, PA 17110-2543

5. The PennDOT Certified Aggregate Technician-in-Training status is only valid from the date of issuance by the DME/DMM until the date of the last scheduled Aggregate Technician Certification Course in the same year and will be acceptable in all Districts for that period.

6. Applicant must take the next available Aggregate Technician Certification Course at Harrisburg Area Community College (HACC).

7. The Aggregate Technician in Traning MUST become a PennDOT Certified Aggregate Technician by following the Initial Certification procedure in Section III.

III. AGGREGATE TECHNICIAN - INITIAL CERTIFICATION

A. Initial Certification Requirements

1 Applicant must have a valid Aggregate Technician-in-Training certification.

2 Applicant must attend and successfully complete PennDOT's Aggregate Technician Certification Program at HACC.

B. Initial Certification Application Procedures

1. Applicant must fill out and submit the completed registration form to HACC including a list of the quarries, dates, and the name of their immediate supervisor where they received one (1) year or more of experience in aggregate testing or a copy of their Aggregate Technician-in-Training certification.

2. Applicant must attend and successfully complete the PennDOT's Aggregate Technician Certification program.

3. The Department or its administrative representative will issue a wallet card upon successful completion of the above requirements. This card will be valid for a period of five (5) years.

Note: Should an individual allow their status as a PennDOT Certified Aggregate Technician to lapse, the Department will require them to retake and successfully complete the next available PennDOT's Aggregate Technician Certification Program at HACC. If the individuals certification is expired for more than two years, the individual will be required to repeat the process outlined in Section III, Initial Certification.

IV. AGGREGATE TECHNICIAN - RECERTIFICATION

A. Recertification Requirements

1. Applicant must have been a certified Aggregate Technician for the previous five (5) years prior to application for recertification.

2. Applicant must successfully complete the Aggregate Technician Recertification Test prior to the expiration date on the certified aggregate technician's wallet card..

3. Applicant must have performed 500 hours of technician experience.

B. Recertification Application Procedures

1. List the quarries, dates, and the name of applicant's immediate supervisor where applicant received 500 hours or more technician experience since date of last certification. Provide the list to the DME/DMM prior to taking the Aggregate Technician Recertification Test

2. The DME/DMM or their representative will evaluate the applicant as per the Aggregate Technician Recertification Test. Upon satisfactorily completing the evaluation and providing the list of the quarries, dates, and the name of applicant's immediate supervisor where applicant received 500 hours or more technician experience since date of last certification, the DME/DMM will sign the evaluation form and provide the applicant with the signed form.

3. Complete and submit the NECEPT Registration Form indicating the application is for recertification of an Aggregate Technician. Submit a copy of the signed Aggregate Technician Recertification Test

4. The Department or its administrative representative will issue a wallet card upon successful completion of the above requirements. This card will be valid for a period of five (5) years.

V. RETEST

Applicants may retest twice without success for the PennDOT Aggregate Technician before they are required to repeat the Aggregate Technician Course presented by HACC. There are two ways to retest. Applicants may register to take a retest along with the regularly scheduled certification examination on the last day of any scheduled PennDOT session, as long as there is sufficient space available in the classroom to accommodate them. The alternate is to wait until the end of the current PennDOT Aggregate Technician Certification Program. After all of the participants have had time to receive their test results and review their exams, a Retest Session will be scheduled and applicants for retest will be notified. Applicants must register for retests by submitting a completed current program registration form, using the current course schedule or retest announcement to indicate the specific date(s) and location(s) desired in order of preference, to assure that appropriate test forms will be available. Registration for retest applicants will be confirmed on a space-available basis. A fee will be charged for any retest with the fee amount and method of payment indicated on the current registration form.

VI. PERFORMANCE REVIEW PROCESS

A. Purpose and Makeup

The performance review process evaluates the performance of certified aggregate technicians, in accordance with the requirements outlined in Bulletin 14 and the Aggregate Technician Certification Program, to determine if their substandard performance or intentional misrepresentation requires any action to be taken against their current certification status. The review of a certified aggregate technician's substandard performance or intentional misrepresentation will be conducted by the Technician Certification Board (TCB). The TCB is composed of the representation shown in Table 1.

Table 1
Representation on the Technical Certification Board (TCB)

Organization	Number of Representatives
PennDOT- Innovation and Support Services Division (ISSD)	1
Pennsylvania Aggregates and Concrete Assoc. (PACA)	1
FHWA-PA Division	1

Representatives to the TCB will be identified by their organization through a scheduled meeting of the Aggregate Quality Improvement Committee (AQIC) or other official means. Each representative will serve for a three-year term. Representatives may serve on the TCB for an unlimited number of consecutive terms.

In general, the review process will rely on written documentation of a certified aggregate technician not following practices identified in the Aggregate Technician Certification Program or intentionally misrepresenting quality of the work. The written documentation should only be provided to the TCB after the certified aggregate technician has been verbally notified that they are not following practices identified in the Aggregate Technician Certification Program or that they have intentionally misrepresented quality of the work. The TCB will review the written documentation and allow for an interview prior to making a determination on the certification status of the certified aggregate technician under review.

B. Procedure

1. Certified Aggregate Technician Not Following Practices, Procedures and Specifications

The official procedure when a certified aggregate technician is not following, or has not followed, practices identified as acceptable PennDOT practices, procedures and specifications, is as follows:

a. A PennDOT, Consultant, Industry or other certified aggregate technician, hereafter referred to as the Observer, observes another certified aggregate technician, hereafter referred to as the technician, not following a practice or practices identified in the Aggregate Technician Certification Program. Immediately, the Observer is to verbally notify the technician that they are not following a practice or practices identified in the Aggregate Technician Certification Program. The Observer must record the verbal notification, including the time, date, location, technician's name and company or organization, and the specific practice or practices not being followed.

b. If a second occurrence is observed where the same technician is not following a practice or practices identified in the Aggregate Technician Certification Program, immediately, the Observer is to again verbally notify the technician that they are not following a practice or practices identified in the Aggregate Technician Certification Program. In addition, the Observer must notify the technician's supervisor, by verbal or written communication, that the technician is not following a practice or practices identified in the Aggregate Technician Certification Program and that the technician has been verbally notified for two occurrences. The Observer is to record the second occurrence and the notifications given to the technician and the technician's supervisor as detailed in VI.B.1.a.. In addition, the Observer is to record the name of the technician's supervisor, the date, and the time (if verbal notification was given) that the supervisor was contacted.

c. If a third occurrence is observed where the same technician is not following a practice or practices identified in the Aggregate Technician Certification Program, immediately, the Observer is to again verbally notify the technician that they are not following a practice or practices identified in the Aggregate Technician Certification Program. In addition, the Observer is to officially document the entire situation. The official documentation should provide as much detail as possible, providing as a minimum, the full name and certification number of the Observer, the S.R., Section, Contract Number, Quarry Name and Location, the full name and certification number of the technician, and the full name of the technician's supervisor. The Observer is to provide copies of all previously recorded verbal or written notifications and a detailed account of the entire situation. Only one document will be accepted by the TCB per situation and, for this reason, it is important to include all pertinent information in this documentation. Pending action by the TCB, the technician will be temporarily suspended.

d. Upon the third occurrence of the same technician not following a practice or practices identified in the Aggregate Technician Certification Program, the technician will be removed from the project or plant, may be restricted in the work they can do, or may be temporarily suspended until the situation is reviewed by the TCB. If temporarily suspended, the technician must immediately forfeit their valid wallet-sized certification card to the DME/DMM or appropriate Department personnel. The DME/DMM or appropriate Department personnel will hold the confiscated wallet-sized certification card. The temporary suspension will restrict the technician from doing any technician work, including materials testing or materials certification, on Department construction or maintenance projects or any projects using liquid fuels tax monies.

e. The Observer is to provide one photocopy of the documentation to the technician and retain one photocopy in their project or plant office files. The Observer is to submit the original copy of the documentation to the Chairperson of the Technician Certification Board at the following address:

Chairperson, Aggregate Technician Certification Board
PA Department of Transportation
Innovation and Support Services Division
81 Lab Lane
Harrisburg, PA 17110

Submit documentation within 14 calendar days of the date of the third occurrence. Documentation not received by the Innovation and Support Services Division within 21 calendar days of the third occurrence will be void.

f. The technician will be afforded the opportunity to submit a written appeal to the Chairperson of the TCB at the address indicated in VI.B.1.e. and, the opportunity to appear before the TCB. The technician is to provide one photocopy of the appeal to the Observer and to retain one photocopy for their project files. Only one written appeal will be accepted by the TCB per situation and, for this reason, it is important to include all pertinent information in the written appeal. Submit written appeals to the Chairperson of the TCB within 35 calendar days of the documented third occurrence. Appeals received more than 40 calendar days after the third occurrence will be void.

g. The documentation and written appeal (if provided) will be logged by the Innovation and Support Services Division and then forwarded to the chairperson of the TCB for action.

h. The chairperson of the TCB will review the documentation and the appeal (if provided) with the other members of the TCB. The TCB will provide a written response to the Innovation and Support Services Division, Laboratory Testing Section within 21 calendar days from the date the documentation was sent to the TCB. The written response will provide the action that is to be taken concerning the situation. The written response of the TCB will be final and will be logged and filed by the Innovation and Support Services Division, Laboratory Testing Section. Possible actions of the TCB will include but are not limited to: TCB written warning; TCB written reprimand; TCB certification suspension (1, 2, or 3 months); TCB rescindment of certification. TCB suspension or rescindment of certification will require the technician to forfeit their wallet-sized certification card to the TCB.

i. The Innovation and Support Services Division, Laboratory Testing Section will immediately forward the TCB's written response concerning certification status to the technician.

2. Certified Aggregate Technician Involved in Deceptive, Questionable or Unethical Activities.

a. A PennDOT, Consultant, Industry or other certified aggregate technician, hereafter referred to as the Observer, observes or becomes aware of an action of another certified aggregate technician, hereafter referred to as the technician, which may be an attempt to mislead or deceive others about the quality of the materials, about materials testing, or about test results or, an action which may be questionable or unethical. Immediately, the Observer is to report the incident to the appropriate DME/DMM, or other appropriate Department personnel. Together the Observer and the DME/DMM, or other appropriate Department personnel, are to immediately contact any member of the TCB. Initial contacts and information concerning these actions will be kept strictly confidential.

b. The DME/DMM, or other appropriate Department personnel, will coordinate with the TCB to institute an investigation of the action. The investigation will determine whether or not the deceptive, questionable, or unethical action was willful. The investigation will be documented to support the final determination.

c. With support from the TCB member initially contacted, and before the investigation is completed, the technician and the technician's supervisor or employer will be verbally notified immediately by the DME/DMM, or other appropriate Department personnel, that the technician will be restricted in the work they can do and will be temporarily suspended, until the investigation is completed and reviewed by the TCB. If temporarily suspended, the technician must immediately forfeit their valid wallet-sized certification card to the DME/DMM or appropriate Department personnel. The DME/DMM, or appropriate Department personnel, will hold the confiscated wallet-sized certification card pending the investigation by the TCB. Temporary suspension will restrict the technician from doing any technician work, including materials testing or materials certification, on Department construction or maintenance projects or any projects using liquid fuels tax monies.

d. The DME/DMM, or other appropriate Department personnel, with coordination from the TCB, will complete the investigation and officially document the entire incident and subsequent investigation. The documentation should provide as much detail as possible and be similar to the documentation required in VI.B.1.c.. The DME/DMM or appropriate Department personnel will provide copies and submit the documentation as instructed in VI.B.1.e. above and within 21 calendar days of the verbal notification described in VI.B.2.c.

e. The technician will be afforded the opportunity to submit a written appeal and request an interview with the TCB. Provide copies and submit written appeals as instructed in VI.B.1.f. and within 35 calendar days from the date of the verbal notification described in VI.B.2.c. Appeals received more than 40 calendar days after the verbal notification described in VI.B.2.c.will be void.

f. The documentation and appeal (if provided) will be considered by the TCB as described in VI.B.1.g. to VI.B.1.i.

VII. AGGREGATE TECHNICIAN CODE OF ETHICS

The Technician Certification Board (TCB) has found that the following rules are necessary to establish and maintain the high standard of integrity and dignity in the aggregate technician profession and are necessary in the public interest to protect the public against unprofessional conduct on the part of the aggregate technician. Certified Aggregate Technicians are put on notice that an ethical violation by themselves or by an individual rendering or offering to render aggregate technician services under their supervision, as provided by this Publication, may result in disciplinary procedures against them in accordance with Section VI.B.2.

A. **Principle 1. Beneficence/Autonomy.** A certified aggregate technician will demonstrate a concern for the welfare and dignity of the recipients of the services, including Department personnel.

1. A certified aggregate technician will provide services without discriminating on the basis of race, creed, national origin, sex, age, handicap, disease, social status, financial status, or religious affiliation.

2. A certified aggregate technician will act for his/her client or employer in professional matters as a faithful agent or trustee, and will not accept a direct fee for services rendered as a certified aggregate technician from other than the technician's employer.

3. A certified aggregate technician will not attempt to injure falsely or maliciously, directly or indirectly, the professional reputation, prospects, or business of anyone.

4. A certified aggregate technician will not attempt to supplant another aggregate technician after definite steps have been taken toward his/her employment.

5. A certified aggregate technician will not compete with another aggregate technician for employment by the use of unethical practices.

6. A certified aggregate technician will not review the work of another aggregate technician for the same client, except with the knowledge of such aggregate technician, or unless the connection of such aggregate technician with the work has terminated.

7. A certified aggregate technician will not attempt to obtain or render technical services or assistance without fair and just compensation commensurate with the services rendered: Provided, however, the donation of such services to a civic, charitable, religious, or eleemosynary organization will not be deemed a violation.

8. A certified aggregate technician will not advertise in self-praising language, or in any other manner, derogatory to the dignity of the profession.

B. **Principle 2. Competence.** A certified aggregate technician will maintain high standards of professional competence.

1. A certified aggregate technician will not attempt to practice in work in which the aggregate technician is not proficient or practice in work outside the standards of the profession.

2. A certified aggregate technician will consult with other service providers when additional knowledge and expertise is required.

3. A certified aggregate technician will accurately record and report information related to aggregate technician services provided to the Department.

4. A certified aggregate technician will require those whom the technician supervises in the provision of aggregate technician services to adhere to this Code of Ethics.

C. **Principle 3. Public Information.** A certified aggregate technician will provide accurate information about aggregate technician services.

1. A certified aggregate technician will accurately represent their competence and training.

2. A certified aggregate technician will not use or participate in the use of a form of communication that contains a false, misleading, or deceptive statement or claim.

3. A certified aggregate technician will not use or permit the use of their signature on work over which the technician was not in responsible charge.

D. **Principle 4. Professional Relationships.** A certified aggregate technician will function with discretion and integrity in relations with colleagues and other professionals.

1. A certified aggregate technician will report illegal, incompetent or unethical practice by colleagues or other professionals to the appropriate authority.

2. A certified aggregate technician who employs or supervises colleagues will provide appropriate supervision as necessary to provide aggregate technician services in conformance with this Code of Ethics.

Aggregate Technician -Certification/Re-Certification Test

PASS / FAIL

NAME____DATE ____________________

NECEPT #______________________COMPANY _______________________________

Technician must be able to perform the following:

		Y	N
1.	Sample aggregates in accordance with AASHTO T-2.	Y ❑	N ❑
2.	Reduce sample of aggregate to testing size in accordance with AASHTO T-248.	Y ❑	N ❑
3.	Sieve analysis of aggregate in accordance with PTM No. 616.	Y ❑	N ❑
4.	Amount of material finer than No. 200 sieve in aggregate in accordance with PTM 100.	Y ❑	N ❑
5.	Determining the percentage of crushed fragments in gravel in accordance with ASTM D-5821.	Y ❑	N ❑
6.	Unit weight of aggregate in accordance with AASHTO T-19.	Y ❑	N ❑
7.	Total moisture in anti-skid material in accordance with PTM No. 513.	Y ❑	N ❑
8.	Knowledge of Plant Book Documentation.	Y ❑	N ❑
9.	Completion of CS-4171 Certification.	Y ❑	N ❑
10.	Plot test results on straight lines and establish action points.	Y ❑	N ❑
11.	Documentation of failures and action required according to their Quality Control Plan.	Y ❑	N ❑
12.	Knowledge of truck loading and weighing procedures.	Y ❑	N ❑
13.	Calibrate Equipment	Y ❑	N ❑
14.	Thin & Elongated particles in accordance with ASTM D 4791	Y ❑	N ❑

REMARKS ____

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Witnessed By___________________________________Date ____________________
Signature

DME / DMM____________________________________Date ____________________
Signature

Introduction to Aggregate Rocks and Minerals

II. Introduction to Aggregates

A. Video:

"Aggregate Production and Stockpiling" by the Virginia Department of Highways. This is a general video, the information of which applies to Pennsylvania; 24 minutes.

B. General Statement:

The starting point for aggregate materials is what is mined in the quarry or pit. It is normally not the responsibility of the aggregate technician to control or direct the extraction of the materials. That responsibility is most often held by the quarry foreman and/or superintendent. Before mining is executed, the person(s) in charge of the extraction should have a practical understanding of the deposit characteristics, which is its geology. Very few aggregate deposits will be completely uniform in all directions. As variations occur, the aggregate quality may change, sometimes by a lot and sometimes hardly at all.

It is the responsibility of the aggregate technician to advise his supervisor if distinct changes in the aggregate characteristics, good or bad, are noticed. The aggregate technician can be the early warning system for subtle changes in geology that affects its quality.

It should not be the aggregate technician's job to supervise geologic investigations concerning the deposit characteristics that result in judgments about future reserves. The practice of geology requires a trained geologist who has a specialized education. In the Commonwealth of Pennsylvania, the practiceof geology is a regulated profession just like the practice of engineering. If aggregate technicians are asked to perform work which is outside the limits of their education or training, they should resist; otherwise they may find themselves blamed for circumstances that go wrong.

It will be useful the aggregate technician to have a brief understanding of basic geology as it may affectaggregate materials. This information s not given as a basis for practicing geology, but rather to acquaint the technician with the general range of geologic settings that may influence an aggregate deposit's quality.

C. <u>Introduction of Aggregate Rock and Minerals:</u>

1. <u>Minerals:</u>

Publication 408, Section 703, specifically mentions the deleterious minerals: chert, gypsum, iron sulfide (pyrite), amorphous silica (i.e. chert), and hydrated iron oxide (limonite). The common minerals quartz, feldspar, and calcite will also be shown.

2. <u>Rocks:</u>

Rocks are generally defined as material composed of one or more minerals in varying amounts that have a similar origin.

3. **<u>Geologic origin</u>**:

- *<u>Igneous</u>*: diabase (trap rock), granite
  These are rocks that have formed from molten material, magma or lava.

- *<u>Sedimentary</u>*: conglomerate, sandstone, siltstone, shale, limestone, dolomite
  These are rocks that have been weathered from older rocks into fragments, transported by water and deposited in a quiet basin.

- *<u>Metamorphic</u>*: quartzite, slate, argillite, schist, serpentine, gneiss
  These are older rocks that have been altered by heat and pressure changing the orientation and chemistry of the older rocks.

4. Aggregate Sources for Pennsylvania:

Sources of aggregate in Pennsylvania are from four distinct types of rock deposits, each of which has specific characteristics that determine the type of aggregate being mined. Following are examples of aggregate deposits from each rock type and their typical characteristics.

a. Sedimentary Rock Deposits:

Sixty percent of the aggregates in Pennsylvania are derived from sedimentary rocks. Sediments are derived from chemical reactions in water, or from the weathering and erosion of preexisting rocks or soil, and the subsequent transportation, erosion, and deposition of the sediments, which are the consolidated, or lithified, to form sedimentary rocks. Limestone, dolomite, sandstone, and siltstone are the most commonly mined sedimentary rocks in Pennsylvania. Limestones and dolomites are typically found in the valleys of Pennsylvania whereas the sandstones and siltstones are usually found underlying ridges. Sedimentary rocks can grade into, or be interbedded, with each other.

Limestone and dolomite are referred to as “carbonate” rocks because they share the fundamental anionic structure of CO_3^{2-}. Carbonates make up a third of the aggregate used in Pennsylvania. Limestones are mainly composed of the mineral calcite ($CaCO_3$), and dolomite of the mineral dolomite ($CaMg(CO_3)_2$). There can be gradations between the two carbonate rocks, ranging from pure limestone (100% $CaCO_3$) to pure dolomite (45.7% $MgCO_3$). Generally, if the rock contains more than 25% $MgCO_3$ it is referred to as a dolomite. The difference between the two types is illustrated by their reaction to dilute hydrochloric acid (HCl): limestone reacts vigorously and dolomite much less so.

Limestone and dolomite can occur as distinct units or can be interbedded, or mixed, with each other. In carbonate rocks, a change in bedding may reflect a change in the rock chemistry. Limestones and dolomites will often contain non-carbonate sediments, which are referred to as acid-insoluble residue, because they do not dissolve in concentrated HCl. Acid-insoluble residue commonly consists of quartz and clay minerals. Because of the soft nature of limestone, skid resistance levels are generally low. However, increasing amounts of sand-sized acid-insoluble residue consisting of quartz and other hard minerals will improve skid resistance, thereby allowing safe use of carbonate aggregates in roads with higher amounts of traffic. Dolomites, which are harder than limestones, frequently have slightly higher skid resistance levels.

Limestones and dolomites usually have low sodium sulfate soundness and moderate Los Angeles abrasion losses. However, both may also have shaly partings and/or layers that can result in high sodium sulfate soundness losses.

Sandstone and siltstone are clastic sedimentary rocks composed of sand- to silt- sized grains set in a matrix of silt or clay and more or less firmly cemented by silica, iron oxide, calcium carbonate. Sandstones and siltstones make up a quarter of the aggregates used in Pennsylvania. They are primarily composed of quartz (SiO_2) with varying amounts of feldspar and clay minerals and are layered and can be interbedded with each other.

Sandstone composition ranges from quartzose sandstone (having trace to no matrix) to greywacke sandstone (having more than 15% matrix and consisting of poorly sorted fragments of quartz, feldspar, and other rock fragments). Generally, sandstones and siltstones have the highest skid resistance levels. Quartzose sandstones tend to be brittle and are subject to high Los Angeles abrasion and sodium sulfate soundness losses. Sandstones and siltstones may have shaly partings and/or layers, which can result in high sodium sulfate soundness losses. Weathering will also cause sandstones and siltstones to have high Los Angeles abrasion and sodium sulfate soundness losses. Further, absorption can become a problem with weathered sandstones and siltstones.

Clastic rocks with pebble-sized grains are called conglomerates. As with sandstones and siltstones, weathering or shale partings in conglomerates also reduce quality. Argillites are sedimentary rocks (mudstones) that have undergone mineral reactions due to an increase in heat and pressure. Argillites tend to have lower Los Angeles abrasion and sodium sulfate soundness losses than shale or most sandstones. Shale is a clastic sedimentary rock formed by the compaction of silt, clay, or mud. Shales are characterized by fine laminae that impact fissility subparallel to bedding and cause the rock to split apart. Shale that easily splits apart and is soft is not considered an acceptable aggregate.

b. <u>Igneous Rock Deposits:</u>

Igneous rocks make up one percent of the aggregates used in Pennsylvania. Igneous rocks form by the crystallization of molten rock (magma or lava) as it cools. Rocks that form from magma are intrusive, and rocks that form from lava (magma extruded at the earth's surface) are extrusive. Magma, or molten rock, can intrude into preexisting country rock (surrounding rock) and crystallize, forming dikes (cross-cutting bedding) and sills (parallel to bedding). Uplift and weathering cause these ancient magma chambers to become exposed at the earth's surface. The two most common types of igneous rocks in Pennsylvania are diabase (traprock) and granite.

Diabase is an intrusive rock composed mainly of plagioclase feldspar and pyroxene. It is a very tough and durable aggregate material which has low Los Angeles abrasion and sodium sulfate soundness losses. It is used widely for railroad ballast.

Granite is an intrusive rock composed mainly of quartz, potassium feldspar, and plagioclase feldspar. Granite is a tough and durable aggregate. It usually has moderate Los Angeles abrasion and sodium sulfate losses, although weathered granite will have high losses in both tests.

c. Metamorphic Rock Deposits:

Metamorphic rocks make up two percent of the aggregates used in Pennsylvania. Metamorphic rocks form from any preexisting rock that has changed mineralogically, chemically, and/or structurally because of heat and/or pressure. Common metamorphic rocks in Pennsylvania include gneiss, serpentine, schist, amphibolite, greenstone, slate, quartzite, and marble. Some metamorphic rocks are foliated (contain layers resulting from directed stress) and have the appearance of bedding. In some instances, rocks are metamorphosed by magma that intruded into the country rock as dikes or sills. This is referred to as contact metamorphism and the rock that is formed is called a hornfels. Hornfels is typically a good construction aggregate with low Los Angeles abrasion and sodium sulfate soundness losses. Shale is metamorphosed into phyllite and slate, which have limited applications as construction aggregate because they split easily into thin layers, which do not compact will or meet shapes requirements.

The hard and crystalline nature of most metamorphic rocks usually results in good quality aggregates with low sodium sulfate soundness and moderate Los Angeles abrasion losses. Exceptions include some marbles (metamorphosed limestones or dolomites) which have high Los Angeles abrasion losses and schist, amphibolite, and greenstone, which are rarely used as aggregate because of poor performance in durability tests.

d. Sand and Gravel Deposits:

Gravel deposits in Pennsylvania are mined from glacial and alluvial deposits. They make up over a third of the aggregates used in Pennsylvania.

1). Glacial deposits range in age from 1.5 million to 20,000 years and were deposited under, next to, and in front of the glaciers that covered the northwest and northeast corners of Pennsylvania. The glaciers ground up and milled the underlying bedrock, and pushed the resulting sediment to their margins. Meltwater streams carried sediment long distances from the glacier, resulting in extensive outwash deposits. The quality and gradation of the sand and gravel deposits improved with increased meltwater transport. Fine sediment, such as silt and clay, was deposited in lakes next to and in front of the glacial margin.

Glacial deposits are complex, poorly sorted, with rapid vertical and horizontal changes in grain size, gradation, and mineral composition. The quality of the material can change significantly asa deposit is mined. Gravelly outwash deposits frequently overlie older, more weathered outwash or fine-grained lake of deposits.

Controlling quality properties, such as fines or weathering, can be a challenge in glacial deposits. Areas of coarser-grained material must be utilized to meet the coarse aggregate crush count specifications. Sand production relies on the natural sand content of the glacial deposit, or can be facilitated by crushing boulders (manufactured sand). Mixtures of natural and manufactured sand can be used as well. Glacial deposits contain rock fragments from the landscape that the glaciers flowed across. Many of these rock fragments are not durable and can lower the overall quality of the aggregate.

2). Alluvial deposits are sand and gravel deposits mined from river and stream channels and the adjacent floodplains. In some places, ancient river terraces are mined for their sand and gravel deposits. These sediments are young, although the river terraces next to the stream can be quite a bit older. The older terrace deposits tend to be more weathered. Weathering usually diminishes the quality of the deposit. Many of the same variable characteristics of gradation content that affect glacial deposits are often true of alluvial deposits.

Publication 408
Section 703 Aggregate

Publication 408, Section 703

PennDOT publication 408 defines the terms and specification for fine and coarse aggregate approval in “Section 703: Aggregates” for use in PennDOT projects. The following pages are copied from Publication 408/2020 Change No. 2: Section 703. It is important to always refer to the most recent edition of this publication which can be found at www.penndot.gov; enter Publication 408 in the search box.

SECTION 703—AGGREGATE

703.1 FINE AGGREGATE

(a) General. Fine aggregate is natural or manufactured sand consisting of hard, durable, and uncoated inert particles reasonably free from clay, silt, vegetation, and other deleterious substances such as reactive chert, gypsum, iron sulfide, amorphous silica, and hydrated iron oxide. Substances present in amounts large enough to cause inconsistent performance in asphalt concrete or plastic or hardened portland cement concrete are considered deleterious. Spent foundry sand may be used as fine aggregate in asphalt concrete and flowable fill.

Obtain fine aggregate with physical properties according to Table A from a source listed in Bulletin 14 or approved by the LTS before use.

1. Natural Sand. Natural sand is fine aggregate resulting from glacial or water action. Fine aggregate produced simultaneously with gravel coarse aggregate may contain crushed particles.

2. Manufactured Sand. Manufactured sand is fine aggregate from the controlled mechanical breakdown of rock, air-cooled blast furnace slag, or air-cooled steel slag into sound, approximately cubical particles.

Fine aggregate manufactured from limestone may not be used in concrete wearing surfaces.

Fine aggregate manufactured from steel slag may not be used in cement concrete or mortar mixtures. Steel slag fine aggregate may only be used in asphalt wearing courses with the approval of the LTS however, do not use steel slag fine aggregate in conjunction with steel slag coarse aggregate. Provide steel slag fine aggregate that is uniform in density and quality. If steel slag was manufactured after anuary 1, 2007, traceability of material must be established. If traceability cannot be established, perform chemical testing according to DEP General Permit WMGR144 and submit the test results to the LTS. Cure steel slag fine aggregate according to the following procedure:

- After gradation preparation, place steel slag fine aggregate, whether reclaimed from an old stockpile or processed directly from the steel-making process, in a controlled stockpile. Limit the stockpile size to a maximum of 30,000 tons. Completely soak the steel slag fine aggregate with water before or during stockpiling. Submit the method of constructing and controlling the stockpile to the Representative for review.

- Maintain the stockpile in a uniform moist condition for a period of not less than 6 months. After the minimum cure period, the Representative will sample and test the stockpile for expansive characteristics according to PTM No. 130. The Representative will approve the stockpile for use if the average total volumetric expansion according to PTM No. 130 is less than 0.50%.

- If the stockpile fails expansion criterion, continue curing the stockpile for a minimum of 2 additional months. The Representative will resample and retest the stockpile after the required additional cure period.

The LTS will evaluate the quality of fine aggregates by conducting petrographic analysis according to PTM No. 518 and other tests necessary to demonstrate that required construction of acceptable durability can be achieved.

(b) Production Testing.

1. Personnel and Equipment. Provide and assign to the work a PennDOT Certified Aggregate Technician who will test fine aggregate at the source according to the requirements listed in Bulletin 14.

Provide equipment for acceptance testing and for developing and maintaining a C program to ensure compliance with specification requirements during production according to Bulletin 14.

2. Testing and Documentation. Perform tests as required by Bulletin 14. Evaluate the test results to ensure the quality requirements are met.

Document the results of tests made during production and make them available to the Department upon request.

(c) Grading and Quality Requirements.

1. Gradation. Table A lists the extreme limits for determining the suitability of supply sources.

Control the grading of Type A Fine Aggregate so the fineness modulus of at least nine out of ten consecutive test samples from a single source delivered to a project or plant varies less than ± 0.20 from the average fineness modulus of the consecutive test samples. Determine the fineness modulus according to PTM No. 501.

For asphalt mixtures:

- If directed, vary the gradations within the limits according to Table A.
- A blend of fine aggregates may be used if the proposed gradation limits for blending are approved by the District Executive in writing.
- If filler is required, provide fine aggregate conforming to the gradation according to Table A and use cement, cement dust, fly ash, or fines from the crushing of stone, gravel, or slag reasonably free of clay.

2. Material Finer than the 75 µm (No. 200) Sieve. Determine the loss by washing according to PTM No.100.

3. Minimum Strength Ratio. Determine the organic impurities in fine aggregate (Type A and Type C only) according to AASHTO T 21. If the color value result is greater than Organic Plate No. 3, determine the minimum strength ratio according to AASHTO T 71 and use fine aggregate meeting the strength ratio according to Table A.

4. Soundness Test. Determine the percentage loss after five cycles of immersion and drying using a sodium sulfate solution according to PTM No. 510.

5. Specific Gravity and Absorption. AASHTO T 84.

TABLE A
Fine Aggregate
Grading and Quality Requirements

	Cement Concrete Sand	Asphalt Concrete Sand Type B			Mortar Sand
Sieve Size	**Type A**	**#1**	**#3**	**Filler**	**Type C**
9.5 mm (3/8-inch)	100	100	100		
4.75 mm (No. 4)	95-100	95-100	80-100		100
2.36 mm (No. 8)	70-100	70-100	65-100		95-100
1.18 mm (No. 16)	45-85	40-80	40-80		
600 m (No. 30)	25-65	20-65	20-65	100	
300 m (No. 50)	10-30	7-40	7-40	95-100	
150 m (No. 100)	0-10	2-20	2-20	90-100	0-25
75 m (No. 200)		0-10	0-10	70-100	0-10
Material Finer Than 75 m (No. 200) Sieve Max. Percent Passing	3				
Strength Ratio Min. Percent	95				95
Soundness Test Max. Loss Percent	10	15	15		10
Fineness Modulus	2.30-3.15				1.6-2.5

703.2 COARSE AGGREGATE

(a) General. Coarse aggregate consists of hard, tough, durable, and uncoated inert particles reasonably free from clay, silt, vegetation, and other deleterious substances such as reactive chert, gypsum, iron sulfide, amorphous silica, and hydrated iron oxide. Substances present in amounts large enough to cause inconsistent performance in asphalt concrete or plastic or hardened portland cement concrete are considered deleterious.

The LTS will evaluate the quality of coarse aggregates by conducting petrographic analysis according to PTM No. 518 and other tests necessary to demonstrate required construction of acceptable durability can be achieved.

Furnish coarse aggregate crushed and prepared from one of the materials described below with physical properties conforming to Tables B, C, and D. Obtain coarse aggregate from a source listed in Bulletin 14 or approved by the LTS before use.

1. Stone. Durable stone free from slate texture or cleavage planes.

2. Gravel. Durable gravel particles. For use in cement concrete, wash thoroughly during production. For use in all asphalt wearing courses, unless otherwise specified, a minimum of 85% crushed particles with at least two faces resulting from fracture is required. For use as No. Open Graded Subbase (OGS), a minimum of 75% crushed particles with at least three faces resulting from fracture is required. For all Type A use, the maximum allowable absorption determined according to AASHTO T 85 is 3.0% however, this restriction does not apply to dredged river gravel used in portland cement concrete. For all Type B use, the maximum allowable absorption determined according to AASHTO T 85 is 3.5%.

3. Blast Furnace Slag. By-product of a pig-iron making process. Tough, hard, and durable pieces of air-cooled blast furnace slag. If blast furnace slag was manufactured after anuary 1, 2007, traceability of material must be established. If traceability cannot be established, perform chemical testing according to DEP General Permit WMGR144 and submit the test results to the LTS. Blast furnace slag is excluded from the abrasion requirements. The density (unit weight) of blast furnace slag cannot be less than 70 pounds per cubic foot. If there is more than 5% contamination of steel slag in a stockpile, the stockpile is considered steel slag. Limit the stockpile size to a maximum of 30,000 tons.

4. Steel Slag. By-product of a steel making process. Tough, hard, and durable pieces of steel slag reasonably uniform in density and quality. If steel slag was manufactured after anuary 1, 2007, traceability of material must be established. If traceability cannot be established, perform chemical testing according to DEP General Permit WMGR144 and submit the test results to the LTS. After crushing, grading, and forming a stockpile, take a sample from the stockpile and submit it to the LTS for testing of expansive characteristics. The LTS will accept the stockpile for use if the total expansion determined according to PTM No. 130 is less than 0.50%. Once a stockpile is accepted, do not add to it if it is for Department use. Limit the stockpile size to a maximum of 30,000 tons. If the stockpile fails expansion requirements, cure the aggregate stockpile as follows:

- Rework the stockpile and soak the aggregate completely with water.
- Submit the proposed method of constructing and controlling the stockpile during the cure period for review and acceptance.
- Maintain the aggregate in a uniformly moist condition in the stockpile for a period of at least 6 months. Take a sample after this curing period and submit it to the LTS for testing according to PTM No. 130.
- The Representative will accept the stockpile for use if the total expansion is less than 0.50%. If the stockpile still fails the expansion requirement, continue curing for at least 2 additional months before resampling and retesting.

Aggregate manufactured from steel slag is not acceptable for pipe or structure backfill, in cement concrete, or as subbase. Aggregate manufactured from steel slag may be used for selected granular material, shoulders, selected material surfacing, and in asphalt surface courses.

5. Granulated Slag. By-product of an iron-making process. Granulated blast furnace slag is the granular glassy material formed if molten slag from iron-making is rapidly quenched by immersion in water and contains not more than 3% total iron reported as Fe_2O_3. If granular slag was manufactured after anuary 1, 2007, traceability of material must be established. If traceability cannot be established, perform chemical testing according to DEP

General Permit WMGR144 and submit the test results to the LTS. Limit the stockpile size to a maximum of 30,000 tons.

Provide material containing not more than 20% by mass (weight) of substances that are not granulated slag. Use material with a dry rodded density (unit weight) determined according to AASHTO T 19 of not more than 80 pounds per cubic foot. Provide uniform material having a maximum size of 50 mm (2 inches) and not more than 20% passing the 150 m (No. 100) sieve. Granulated slag may only be used for subbase material as specified in Section 350.

6. Lightweight Aggregate. Acceptable types of lightweight aggregate are as follows:

- Aggregate prepared by expanding, pelletizing, or sintering products such as blast-furnace slag, diatomite, fly ash, clay, shale, or slate.

- Aggregate prepared by processing natural materials such as pumice, scoria, or tuff.

Furnish lightweight aggregate conforming to AASHTO M 195, the soundness and abrasion limits for Type A aggregate according to Table B, and the following durability requirements.

• Aggregate Absorption Factor (PTM No. 526)	Max. %	2.5
• Freeze-Thaw Resistance of Concrete, Decrease of Dynamic Modulus at 300 Cycles (AASHTO T 161, Procedure B, except after 14 days of moist cure, dry the beams 3 inches by 4 inches by 16 inches at 72F ± 3F and approximately 50% relative humidity for 14 days. Then soak the beams in water for 3 days before starting the freezing and thawing test.)	Max. %	60
• Freeze-Thaw Resistance of Aggregate (PTM No. 525)	Max. %	25

TABLE B
Coarse Aggregate
Quality Requirements(7)

	Type A	Type B	Type C	Type S
Soundness, Max. %	10	12	20	16
Abrasion, Max. %	45	45	55	55
Freeze-Thaw Loss, Max %				7.0(6)
Thin and Elongated Pieces, Max. %	15	20		
Material Finer Than 75 m (No. 200) Sieve, Max. %	(1)	(1)	10	10
Crushed Fragments, Min. %	55(2)	55(2)	50	50
Compact Bulk Density (Unit Weight), lbs./cu. ft.	70	70	70	70
Deleterious Shale, Max. %	2	2	10	10
Clay Lumps, Max. %	0.25	0.25	3	3
Friable Particles, Max. % (excluding shale)	1.0	1.0		
Coal or Coke, Max. %	1	1	5	5
Glassy Particles, Max. %	4 or 10(3)	4 or 10(3)		
Iron, Max. %	3(5)	3(5)	3(5)	3(5)
Absorption, Max. %	3.0(4)	3.5(4)		2(4)
Total of Deleterious Shale, Clay Lumps, Friable Particles, Coal, or Coke Allowed, Max. %	2	2	15	15

Notes:
(1) Section 703.2(c)4.
(2) Section 703.2(c)5.
(3) Section 703.2(c)9.
(4) Gravel only for Types A and B. as specified in Section 703.2(c)2. All natural aggregates for Type S.
(5) Section 703.2(c)10..
(6) Natural coarse aggregates with an absorption less than 2% are considered freeze thaw resistant and not subject to testing according to AASHTO T 103, Procedure A. Natural aggregates with an absorption exceeding 2% shall be considered freeze thaw resistant if either their sodium sulfate soundness level is less than 16% or their AASHTO T 103 freeze thaw loss after 25 cycles (coarse fraction) does not exceed 7.0%. Type S 2A aggregate may be supplied where Type 2A aggregate for purposes other than subbase is specified at no additional cost to the Department.
(7) Test methods to determine the quality requirements of Table B as specified in Section 703.2 (c).

7. Recycled Concrete. Salvaged and crushed concrete pavements and concrete highway structures from Department, county, or municipal projects for use as 2A aggregate, shall not be used in subbase.

(b) Production Testing.

1. Personnel and Equipment. Provide and assign a PennDOT Certified Aggregate Technician to test coarse aggregate at the source according to Bulletin 14.

Provide equipment for acceptance testing and for developing and maintaining a C program to ensure compliance with specification requirements during production according to Bulletin 14.

2. Testing and Documentation. Perform tests as required by Bulletin 14. Evaluate the test results to ensure the quality requirements are met.

Document the results of tests made during production and make them available to the Department upon request.

(c) Quality Requirements. The following notes are applicable to Table B.

1. Soundness. Determine the percentage loss after five cycles of immersion and drying using a sodium sulfate solution according to PTM No. 510. The LTS may accept aggregate failing the test if it can be demonstrated in writing the aggregate has a satisfactory service record in both pavements and structures. Acceptable aggregate produced from recycled concrete need not conform to soundness requirements since cementitious material cannot be evaluated with this test.

2. Abrasion. Determine the percentage of loss according to AASHTO T 96.

3. Thin and Elongated Particles. ASTM D4791, Method B, using the material retained on the 4.75 mm (No. 4) sieve. Measure the ratio of 5:1, comparing the length to the thickness of the aggregate particles. Calculate the percentage of flat and elongate particles by mass.

TABLE C
Size and Grading Requirements for Coarse Aggregates
(Based on Laboratory Sieve Tests, Square Openings)

AASHTO Number	Total Percent Passing														
	100 mm (4")	90 mm (3 1/2")	63 mm (2 1/2")	50 mm (2")	37.5 mm (1 1/2")	25.0 mm (1")	19.0 mm (3/4")	12.5 mm (1/2")	9.5 mm (3/8")	4.75 mm (No. 4)	2.36 mm (No. 8)	1.18 mm (No. 16)	300 µm (No. 50)	150 µm (No. 100)	75 µm (No. 200) ***
1	100	90-100	25-60		0-15		0-5								
3			100	90-100	35-70	0-15		0-5							
467				100	95-100		35-70		10-30	0-5					
5					100	90-100	20-55	0-10	0-5						
57					100	95-100		25-60		0-10	0-5				
67						100	90-100		20-55	0-10	0-5				
7							100	90-100	40-70	0-15	0-5				
8								100	85-100	10-30	0-10	0-5			
89								100	90-100	20-55	5-30	0-10	0-5		
9									100	85-100	10-40	0-10	0-5		
10									100	85-100				10-30	
2A				100			52-100		36-70	24-50	16-38	10-30			
OGS				100			52-100		36-65	8-40		0-12			

Applies only for asphalt mixtures.
PennDOT Number – Only Type C and Type S will be listed in Bulletin 14.
For 75 m (No. 200), see Table D.

Note A: A combination of No. 7 and No. 5 may be substituted for No. 57, if no more than 50% or less than 30% of the combination is No. 7 size.

Note B: Provide No. OGS material that has a minimum average coefficient of uniformity of 4.0. The average coefficient of uniformity is defined as the average of the sublots within each lot. Determine the coefficient of uniformity according to PTM No. 149 each time the gradation is determined. The required minimum coefficient of uniformity for individual samples is 3.5. If the coefficient of uniformity of any sample falls below 3.5, reject the lot. Do not use the coefficient of uniformity in the multiple deficiency formula.

4. Material Finer than the 75 µm (No. 200) Sieve. Determine the loss by washing according to PTM No. 100 and Table D.

This test is not required for aggregate processed through a mechanical dryer for use in asphalt concrete however, the aggregate is required to be clean and free of fines that would adversely affect the coating of the aggregate with asphalt material.

This test is not required for AASHTO No. 10 aggregates.

TABLE D
Material Passing the 75 µm (No. 200) Sieve —
(Based on Laboratory Sieve Tests, Square Openings)

Section	Specification	% Maximum
350	Subbase (No. 2A)	10
350	Subbase (No. OGS)	5
470	Bit. Seal Coat	1.0
471	Bit. Seal Coat w/ Precoat. Aggr.	2.0
480	Bit. Surf. Treatment	1.0
704	Cement Concrete	1
	All other uses	2

5. Crushed Fragments. ASTM D5821

6. Deleterious Shale. Determine the percentage of deleterious shale by four cycles of wetting and drying according to PTM No. 519. The LTS will use petrographic analysis to confirm the results.

7. Friable Particles. Percent loss according to PTM No. 620.

8. Coal or Coke. Determine the percentage of mass (weight) by visual identification and hand separation. If required, the LTS will use petrographic analysis to confirm the results.

9. Glassy Particles. Determine the percentage of mass (weight) by visual identification and hand separation. Pieces of slag containing more than 50% glass are considered to be glassy particles. Waste glass is also considered to be glassy particles. For coarse aggregate used in cement concrete, the maximum percentage of glassy particles allowed is 4%. For other uses, the maximum percentage of glassy particles allowed is 10%. Coarse aggregate containing glassy particles consisting of waste glass may not be used in cement concrete or asphalt wearing courses.

10. Metallic Iron. The LTS will use petrographic analysis to determine the content of metallic iron. Pieces of slag containing metallic iron are considered to be metallic iron. This requirement is waived if aggregate with metallic iron is used in asphalt mixtures or subbase. PTM No. 518.

11. Clay Lumps. Determine the percentage of mass (weight) by visual identification and hand separation. If required, the LTS will use petrographic analysis to confirm the results.

12. Specific Gravity and Absorption. AASHTO T 85.

13. Bulk Density (Unit Weight) and Voids. AASHTO T 19.

(d) Testing and Acceptance. Section 703.5(b)

703.3 SELECT GRANULAR MATERIAL (2RC)

(a) General. Select granular material consists of durable bank or crushed gravel, stone, or slag mixed or blended with suitable filler materials to provide a uniform mixture. Obtain select granular material from a source listed in Bulletin 14. Stockpile, sample, and test material before it is used to ensure reasonable uniformity and acceptability. Use material free from vegetable or organic matter, lumps, or an excessive quantity of clay or other objectionable or foreign substances and not more than 10% deleterious shale by mass (weight).

(b) Gradation. Conforming to the following gradation, determined according to PTM No. 616:

- Passing 50 mm (2-inch) sieve 100%
- Passing 4.75 mm (No. 4) sieve 15% to 60%
- Passing 150 m (No. 100) sieve 0% to 30%

703.4 ANTI-SKID MATERIAL

(a) General. For use on ice or snow-covered pavement surfaces, furnish anti-skid material conforming to Table E from a producer or agent listed in Bulletin 14. Do not use material containing metal, glass, or substances harmful to automotive equipment and vehicles. Use material reasonably free of deleterious substances or foreign materials including, but not limited to, dirt, shale, slate, incinerated asphalt coal mine waste, and within the maximum limits of the individual deleterious and total deleterious materials according to Table B, Type C.

(b) Description.

1. Type AS1. Either natural sand, manufactured sand (except slag aggregates), or a combination of the two conforming to the following requirements:

- Bulk Density (Unit Weight). Minimum 70 pounds per cubic foot and not exceeding 110 pounds per cubic foot determined according to AASHTO T 19.
- Crushed Fragments. If natural sand is furnished, not less than 35% of the fragments retained on the 2.36 mm (No. 8) sieve are required to be crushed fragments, determined according to ASTM D5821.
- Iron. Total of individual anti-skid particles containing metallic iron may not exceed 1.0% by mass (weight) of material, determined by dividing the mass (weight) of such particles retained on the 4.75 mm (No. 4) sieve by the total dry mass (weight) of the sample.

2. Type AS2 and AS3. Crushed stone or crushed gravel conforming to the following requirements:

- Bulk Density (Unit Weight). Minimum 70 pounds per cubic foot and not exceeding 105 pounds per cubic foot determined according to AASHTO T 19.
- Los Angeles Abrasion. Abrasion loss not exceeding 55%, determined according to AASHTO T 96, Gradation D.
- Crushed Fragments. If crushed gravel is furnished, not less than 60% of the fragments retained on the 4.75 mm (No. 4) sieve are required to be crushed, one face, determined according to ASTM D5821.
- Iron. Total of individual anti-skid particles containing metallic iron may not exceed 1.0% by weight of material, determined by dividing the mass (weight) of such particles retained on the 4.75 mm (No. 4) sieve by the total dry mass (weight) of the sample.

3. Type AS4. Crushed slag conforming to the following requirements:

- Bulk Density (Unit Weight). Minimum 70 pounds per cubic foot and not exceeding 105 pounds per cubic foot determined according to AASHTO T 19.
- Los Angeles Abrasion. Abrasion loss not exceeding 55%, determined according to AASHTO T

96, Gradation D.

- Iron. Total of individual anti-skid particles containing metallic iron may not exceed 1.0% by mass (weight) of material, determined by dividing the mass (weight) of such particles retained on the 4.75 mm (No. 4) sieve by the total dry mass (weight) of the sample.

(c) Gradations. According to Table E.

TABLE E
Anti-Skid Gradation

Anti-Skid Type	Maximum Percent Passing Sieve								
	31.5 mm (1 1/4")	19.0 mm (3/4")	12.5 mm (1/2")	9.5 mm (3/8")	4.75 mm (No. 4)	2.36 mm (No. 8)	300 µm (No. 50)	150 µm (No. 100)	75 µm (No. 200)*
Type AS1				100	60-100	0-80		0-8	0-5
Type AS2				100	35-80	0-45		0-6	0-3
Type AS3			100	90-100		0-30		0-8	
Type AS4				100		0-30		0-8	0-5

Determined by PTM No. 100.
If the total percent passing the 2.36 mm (No.8) sieve is less than 25%, the total percent passing the 75 m (N0. 200) sieve is allowed to be 0-5.

(d) Testing. If shipping, test material for moisture content according to PTM No. 513. A minimum of two tests per day is required. If conditions exist that would cause a change in moisture content, conduct additional tests. A Department representative will verify the test results.

Document tests at the end of delivery quantity at the end of the day and determine the average moisture content. The Department will adjust the delivery quantity by deducting the average moisture content from the aggregate quantity shipped. Payment is based on the calculated oven dry mass (weight).

703.5 ACCEPTANCE OF CONSTRUCTION AGGREGATES

(a) General. The following describes the certification acceptance of construction aggregates. Accept AASHTO No. 1 Coarse Aggregate as specified in Section 850.2(a)1.

(b) Testing and Acceptance. Certify each day s shipment of aggregate as specified in Section 106.03(b)3.

1. QC. Section 106.03(b)2 and as follows:

- Submit for annual review a C Plan conforming to the minimum Department requirements for aggregate suppliers.

- Establish and positively identify aggregate stockpiles that have been tested according to the approved C Plan and conform to Department Specifications. Material may be added to or shipped from stockpiles at the producer s discretion.

2. Source Verification Samples. Under the direction and supervision of the Representative, obtain a verification sample (n=3) from each stockpile to be tested. Obtain the sample from the stockpile according to AASHTO R 90 or from a mini-stockpile. If the mini-stockpile method is chosen, obtain the sample according to the following procedure:

- Place approximately 10 tons of aggregate into a mini-stockpile on a suitable surface. Use a loader to strike off the top of the mini-stockpile.

- Obtain sufficient material for sampling from random locations on the mini-stockpile using a square faced shovel.

If project verification samples or lot acceptance samples in Section 703.5(b)3 result in a Percent Within Limits

(PWL) 90, the Representative will direct additional source verification sampling of the stockpile(s) from which the failing material was shipped. In such instances, do not ship additional materials from the stockpile(s) until test results from source verification samples have PWL 90.

Immediately deliver the source verification sample to the Representative for testing using the equipment provided as specified in Sections 703.1(b) and 703.2(b). The Representative will test all three increments according to Tables A, B, C, and D, as applicable. If the test results verify the material conforms to the specifications, use the material under certification, unless project verification samples require lot acceptance.

If the material does not conform to the specifications, the Representative will determine the PWL as specified in Section 106.03(a)3. If source verification results indicate a PWL 90, the Representative will reject the stockpile.

If a stockpile is rejected, increase C testing according to the reviewed C Plan. Construct another stockpile of the aggregate to be tested consisting of 300 tons to 500 tons of material or the remainder of the quantity identified for Department projects, whichever is less. The Representative will accept the material under certification if test results verify the material from the new stockpile conforms to the specifications, unless project verification samples require lot acceptance.

3. Project Verification Samples. Under the direction and supervision of the Inspector, obtain verification samples (n=3) according to Table F for aggregates used for subbase applications under the roadway and shoulders as specified in Section 350. At the preconstruction conference provide the Representative estimated aggregate quantities for subbase applications under the roadway and shoulders. Other aggregate types or applications may be sampled for project verification if the Representative determines the material is visually suspect. Obtain samples at the point of placement (loose aggregate sample on grade before trimming and compaction) and not from project stockpiles unless directed:

TABLE F
Verification Samples

Aggregate Quantities	Number of Samples (n=3)
1,000 tons or more, but less than 2,000 tons	1
2,000 tons or more, but less than 10,000 tons	2
10,000 tons or more, up to 25,000 tons	3
Each additional increment of 25,000 tons	1

The Inspector will select sample locations according to PTM No. 1.

Under the direction and supervision of the Inspector, immediately deliver the sample(s) to the test site at either the producers location or the project site. The Inspector will test the sample(s) using the equipment provided as specified in Sections 703.1(b) and 703.2(b). The Inspector will test all three increments for compliance with Tables C and D, plus the Crushed Fragments Test of Table B if applicable. The Inspector will provide the test results within 5 days from the date of sampling. The Department will continue to accept material under certification if test results verify the material conforms to the specifications.

If the material does not conform to the specifications, the Inspector will determine the average PWL of the material as specified in Section 106.03(a)3. If results indicate a PWL 90 for the material, the Department will discontinue certification acceptance and begin project lot acceptance of the aggregate. Discontinue all operations using that size of aggregate until the Representative determines new lot sample locations according to PTM No. 1 and authorizes operations to continue. Conduct lot acceptance testing at the point of placement according to the following procedure:

- Under the direction and supervision of the Inspector, use a PennDOT Certified Aggregate Technician to obtain an acceptance sample (n=3) at the point of placement (loose aggregate sample on grade before trimming and compaction) for each 7,500 tons of material placed. The lot size of 7,500 tons will be divided into three equal sublots.

  - The Inspector will select sample locations according to PTM No. 1. The Inspector will take possession of the sample and immediately transport the sample from the sampling point to the testing site. The Inspector will test all three sample increments for compliance as specified in Section 703.2(c), Tables C and D plus the Crushed Fragments Test of Table B. Aggregates other than gravel will use 100 as the PWL for the Crushed Fragments Test according to Table

B. The Inspector will provide the test results within 5 days of sampling. Failure to provide test results within the targeted timeframe will not form a basis to dismiss the test results, and the test results will govern in all cases.

- If less than 7,500 tons remain for the project, the remaining quantity will be considered a lot. Divide the remaining approximated quantity into three equal sublots so three increments are obtained.
- If a change in aggregate sources is made before three increments are obtained for a lot, obtain additional increments from remaining materials on the project to provide one full acceptance sample (n=3) from the first source.
- The Inspector will document the placement location(s) by station of material placed to clearly delineate the location of all material within the lot.

- The Department will continue project lot acceptance testing until five consecutive lots are accepted at 90 PWL. Once five consecutive lots are accepted at 90 PWL, acceptance may again be by producer certification and verification testing will begin again at the frequency according to Table F for the remaining project quantity. The Contractor will be charged 600 for each lot of material placed, for the project lot acceptance testing performed by the Inspector.
- For all test values, the Department will determine the lot PWL as specified in Section 106.03(a)3. If results indicate a PWL 90, the lot is accepted at full payment. If results indicate a PWL 90 for the material, the Department will determine the Degree of Non-Conformance (DNC) for the lot according to the following:
  - Lot average values for all sieve sizes which do not conform to the specified limits will be used to calculate the DNC. For each sieve where the average does not conform to specifications, the difference between the average test value and the closest specified limit will be computed (upper limit for average values where the upper limit has been exceeded or lower limit for average values where the lower limit was not reached). Each difference will be multiplied by the factor according to Table G.
  - Crushed fragment average test results which do not conform to the specified limits will also be included in the DNC. The DNC will include the difference between the lower specified limit and the lot average crushed fragment test results.
  - The Department will determine the total DNC for the lot by summing of all the non-conformances for each sieve size and crushed fragments after each has been multiplied by applicable factors according to Table G and Table H. The total DNC will be used to adjust the payment represented by the non-conforming lot according to Table I.

TABLE G
Multiplication Factors for DNC

Sieve Size	**Multiplication Factor**
4 inch to No. 4 inclusive	1.0
No. 5 to No. 80 inclusive	1.5
No. 100	2.0
No. 200 (Table D)	Table H
Crush Count	1.0

TABLE H
No. 200 Sieve Upper Limit and Multiplication Factor

% Maximum	Upper Limit To Calculate DNC	Multiplication Factor
10	10.49	2.5
5	5.49	2.5
2	2.49	2.5
1	1.49	2.5
2.0	2.05	5
1.0	1.05	5

TABLE I
DNC Pay Reduction Percent

<table>
<tr><th>Total Sum of DNC</th><th>Percent of Contract Unit Price Reduction</th></tr>
<tr><td>0.5 to 3.0</td><td>2%</td></tr>
<tr><td>3.1 to 5.0</td><td>4%</td></tr>
<tr><td>5.1 to 8.0</td><td>7%</td></tr>
<tr><td>8.1 to 12.0</td><td>11%</td></tr>
<tr><td>Greater than 12.0</td><td></td></tr>
<tr><td colspan="2">If the sum of the DNC is greater than 12.0, the Representative will direct the material represented by the lot (n=3) be removed and replaced at no additional cost to the Department or left in place and final payment for the material will be at 70% of the contract unit price. Pending the decision by the Representative, do not place additional materials on or incorporated with the non-conforming material.</td></tr>
</table>

4. QA Samples. CMD A samples (n=3) may be taken at the source of supply or at the point of placement on the project. Submit samples to the LTS for testing. If results for any type of material indicate a PWL of less than 90, the District will immediately obtain an additional verification sample (n=3) at the appropriate site (project or source). The Department will test all three sample increments at either the producer s location or at the project site and determine the PWL for the material. If results indicate a PWL for the material of less than 90, obtain source verification samples and project verification samples as specified in Section 703.5(b)2 and Section 703.5(b)3.

(c) Weighing Responsibilities. Prepare weight slips and certifications attesting to the accuracy of the weights recorded and ensuring conformance as specified in Section 107.23(b). Designate a licensed weigh person(s) to act as the Contractor s agent. Ensure scales are calibrated annually by an independent agency acceptable to the Department. A Department Inspector may provide random checking.

Weigh empty trucks used to haul material measured by mass (weight) daily unless otherwise directed. If the invoice mass (weight) exceeds the net mass (net weight) determined by a Department mobile weigh team by more than 3%, the Department will consider the deviation to be excessive. Take immediate corrective action upon notification of an excessive deviation. Within 30 days of notification, provide the District Executive with a written description of corrective actions and safeguards and the time they were implemented.

703.6 CERTIFICATION OF AGGREGATES AT ASPHALT AND CEMENT CONCRETE PLANTS

(a) Certification. Certify aggregate at asphalt and cement concrete plants yearly for quality requirements as specified in Section 106.03(b)3 using Form CS-4171 or another acceptable form.

Material Quality Testing

IV. Material Quality Tests

Approved aggregate sources must demonstrate that their products meet the acceptability requirements established by PennDOT through a series of test. Among these are tests for soundness, durability, particle shape, chemical reactivity, and known deleterious materials. The quality requirements are itemized in Publication 408 in Section 703.1 (c), Table A for fine aggregate; and Section 703.2(a) Table B for coarse aggregate. On a periodic basis, "at intervals sufficient to ensure the quality of the material" (408, Section 703), certain tests, especially the Sodium Sulfate Soundness test and the Los Angeles Abrasion test, must be performed on the aggregate source. This quality control testing is in addition to the tests performed on material by the Pennsylvania Department of Transportation (PennDOT) as part of the routine biennial requalification. Some aggregate producers have the equipment and experienced personnel necessary to do these tasks themselves. If not, the test may be performed by a qualified testing laboratory that is accredited by the AASHTO Materials Reference Laboratory (AMRL).

The Consensus Property Tests are discussed below.

a. Particle Shape: ASTM D4791

The ideal shape for aggregates is cubical which promotes proper packing and resists segregation and undesirable aggregate layering within a concrete mix. Undesirable aggregate shape can manifest itself as too thin or too long. The method for determining thin and elongated pieces is found in Section 703.2 (c) 3, of Publication 408. The test method is ASTM D 4791, Method B, using the material retained on the 4.75 mm (No.4) sieve. Measuring the ratio of 5:1, comparing the length to the thickness of the aggregate particles. Calculate the percentage of flat and elongate particles by mass.

b. Crushed Fragments: ASTM D 5821

Coarse aggregate that is derived from glacial or alluvial sources may be somewhat rounded in shape and have smooth surfaces. These properties cause inefficient bonding between aggregate particles and cement in Portland cement concrete or may cause the aggregate to glide in asphaltic concrete, which causes rutting. For these reasons, PennDOT requires gravel sources to crush the coarse aggregate so that a certain percentage of the material has fresh broken faces.

The PennDOT specification for percentages of crushed particles, defined by one, two or three fresh faces, for various uses, is described in Section 703.2(a) 2 in Publication 408.

c. <u>Specific Gravity/Absorption: AASHTO T84</u>

Aggregates can absorb water or other liquids, such as asphalt. This tendency toward absorption will affect bituminous formulations and other aggregate properties. Highly absorptive aggregate is commonly thought to be more susceptible weathering. This is an intuitive conclusion. However, the specific proof of this relationship between absorption and quality is often difficult to demonstrate. In general, most highly absorptive aggregates are weathered.

The basic material quality tests are discussed below.

d. <u>Sodium Sulfate Soundness: PTM 510</u>

Some rock types can disintegrate rapidly when subjected to repeated cycles of mechanical weathering such as wetting and drying or freeze-thaw conditions like we have in Pennsylvania. The soundness test was developed to predict which rock types are prone to freeze-thaw degradation. The soundness test is a substitute, in principle, for the Freeze-Thaw Test (AASHTO T-103).

The soundness test that is used in Pennsylvania is the Sodium Sulfate Soundness test, however, in some states, like New York, magnesium sulfate is used. Both coarse and fine aggregates are subjected to this test method.

A specified amount of specific sizes are first soaked in a sodium sulfate solution for 16-18 hours at 21O ± 1.0o C and then dried for 5-5 ½ hours at 110o ± 5o C. After cooling, the soaking and drying cycles are repeated for an additional 4 times, for a total of 5 cycles.

The sodium sulfate is then washed from the sample, which is then dried, sieved over a set of critical sieves and weighed. The “loss” represents the difference in weight before the start of the test and the weight retained on the critical sieves after the test.

e. <u>Los Angeles Abrasion Test: AASHTO T96</u>

The Los Angeles Abrasion Test, whose actual title is “Standard Test Method for

Resistance to Degradation of Small Size Coarse Aggregate b Abrasion and Impact in the Los Angeles Machine", is a critical quality test that is performed on coarse aggregate only. The test is designed to measure the resistance the aggregate has to impact degradation, grinding, and abrasion.

The testing apparatus consists of a large steel drum that revolves with steel balls inside. A change of aggregate of a specified grading and weight is placed into the drum which revolves for 500 revolutions. The aggregate is then removed and screened over the #12 sieve. The material passing the sieve is the loss fraction. The test can be performed on various size distributions of aggregate that are called gradings. The grading used for PennDOT #8 qualification is the "C" grading and for the #57 it is the "B" grading.

Typical aggregates range between 15% to 30% loss with anything under 15%, and especially below 10%, being a very low (good) result, very few rock types will yield that low of a loss. The upper limit for PennDOT Type "A" and "B" aggregate is 55%.

f. <u>Deleterious Shale: PTM 519</u>

Shale is a thinly bedded rock composed mainly of clay. It is generally an undesirable material for aggregate usage because it splits apart into thin wafers and may be subject to rapid disintegration. However, there are shaly rocks that are not strictly shale because they contain silt and have been hardened by geologic processes. Such thinly bedded shale-like rocks may or may not be acceptable for aggregate usage.

In addition to other standard test, such as Sodium Sulfate Soundness, PennDOT has developed a test to distinguish deleterious from non-deleterious shale. This procedure is the Wet-Dry Durability Test (PTM 519), which is conducted on +1/4" fragments.

g. <u>Clay Lumps:</u>

Clay lumps, which will disintegrate upon usage, are obvious undesirable material in aggregate. Clay lumps usually originate from overburden above rock or clay wedges that extend down into the rock in solution cavities or fractures.

h. Friable Particles: PTM 620

Friable particles are similar to clay lumps, but consist of soft or crumbly rock, usually resulting from weathering. There is a specific technique described by PTM 620, to determine if a suspected rock is friable.

i. Coal or Coke: PTM 518

Coal or coke are uncommon in aggregate materials, but may occur in some locations. In certain geologic sequences, coal layers can be found with layers of sandstone or siltstone that are quarried or mined for aggregate. In those circumstances, selective mining would be necessary to ensure that the coal was not incorporated into the aggregate materials.

Another instance of coal contamination can occur when coal-processing waste is reclaimed for aggregate. Both bituminous and anthracite coal are unsound aggregates, and can adversely affect the density of an asphalt mix. Coke, or chemically reduced coal (from heating at high temperatures in the absence of oxygen) might inadvertently find its way into aggregate where old coke piles are near aggregate plants, but that situation is rare. Coke is also found in slag aggregates which are processed for use from old slag.

j. Glassy Particles: PTM 518

This is a quality issue for slag used for aggregate. In Pennsylvania, there are no natural glassy aggregates. Glassy particles are not desirable in aggregate because of potentially detrimental chemical reactions and other quality issues.

k. Iron:

Elemental iron (what a nail is made of) that can be detected with a hand magnet is another undesirable material that can be found in slag. This is not an issue in natural aggregates where the iron is chemically combined with other elements to form minerals such as iron oxide or iron carbonate. Elemental iron will rust and cause staining, which is an undesirable characteristic in aggregates, especially those used in Portland cement concrete. This prohibition against iron is usually waived for use in bituminous mixtures.

The main safety tests will be discussed below.

l. Alkali Silica Reactivity (ASR): ASTM C1293

Aggregate materials are evaluated for their potential to react in the presence of a highly alkaline environment. Portland cement has such an environment, although the alkali content of cement paste can vary from source to source. The reaction that can occur between the aggregate and the cement is the dissolution of silica from the aggregate and the formation of silica gel which can coat the aggregate or extrude into cracks. These gels are very hydroscopic and absorb water, causing swilling, expansion, and the possible destruction of the concrete. This reaction can occur quickly or it may take years to develop.

There are a number of tests that have been used to evaluate aggregates to see if they are alkali reactive. The test method used by PennDOT is ASTM C1293. The test method measures the potential for expansion of a combination of aggregate and high alkali cement that have been mixed and placed in a mold to form a prism. The prism is removed from its mold after approximately 24 hours. An initial length measurement of the prism is made after the prism is removed from the mold. Additional readings are performed at 7 days, 28 days, 56 days as well as 3, 6, 9, and 12 months. The length change is compared to the average length change of the other prisms being tested at each time interval. Refer to Publication 408, Section 704 Cement Concrete, and is included in the following pages.

m. Skid Resistance Level:

PennDOT classifies all Type "A" aggregate for Skid Resistance Level (SRL). This classification specifies the permissible use of the aggregate for bituminous surface, or course, treatment depending on the Average Daily Traffic (ADT) of the roadway. The following chart from PennDOT Bulletin 14 shows the classification levels for various ADTs.

SRL is a measure of an aggregate's resistance to polishing from traffic. Depending on an aggregate rock type, selective tests are used by PennDOT to determine its SRL. These include field testing of pavement surfaces with a skid trailer, or when that is not feasible, laboratory methods such as the British Wheel and Pendulum and insoluble residue analysis are use. PennDOT may also rate an aggregate based on geologic comparison to a known source.

Publication 408
Section 704 Cement Concrete

Publication 408, Section 704

PennDOT publication 408 defines the terms and specification for fine and coarse aggregate approval in "Section 704: Cement Concrete" for use in PennDOT projects. The following pages are copied from Publication 408/2022 Change No. 5: Section 704. It is important to always refer to the most recent edition of this publication which can be found at www.penndot.gov; enter Publication 408 in the search box.

SECTION 704—CEMENT CONCRETE

704.1 GENERAL—

(a) Description. Furnish the indicated class of cement concrete according to the requirements of Table A. Cement concrete is a mixture of portland cement, fine aggregate, coarse aggregate, water and air-entraining admixture, with or without water reducing admixture, retarding admixture, or supplementary cementitious material (SCM).

The methods of producing concrete referred to in these Specifications are defined as follows:

1. Plant Mixed Cement Concrete. Concrete proportioned and mixed in either a stationary, commercial, and central plant or a stationary plant located near the project. Concrete is delivered to the work site by truck, agitator truck, or mixer truck.

2. Truck Mixed Cement Concrete. Concrete prepared by dry batching in a proportioning plant and placing the dry ingredients in a truck mixer. Measured water is then added to the truck drum from the plant water system and the concrete is mixed in the truck at the plant. Mixing is not allowed en-route to or at the work site.

3. Volumetric Mixed Cement Concrete. Concrete proportioned and mixed in a truck-mounted mobile mixer. The unit is capable of proportioning concrete ingredients from self-contained bins and mixing the materials with measured water in a self-contained mixer. The concrete is mixed and discharged at the work site.

(b) Material.

- Cement—Section 701
- Fine Aggregate, Type A—Section 703.1
- Coarse Aggregate, Type A, maximum size AASHTO No. 467, No. 57, No. 67 or No. 8 (Stone, Gravel, or Slag)—Section 703.2
- Coarse Aggregate, Type A Lightweight, Section 703.2(a) 6
- Water—Section 720.1
- Admixtures—Section 711.3
- Supplementary Cementitious Material (SCM)—Section 724

Table A
Cement Concrete Criteria

Class of Concrete	Use	Cement Factor(2)(4) (lbs./cu. yd.)		Maximum Water Cement Ratio(5) (lbs./lbs.)	Minimum Mix(1,7) Design Compressive Strength (psi)				28-Day Structural Design Compressive Strength (psi)
					Days				
		Min.	Max.		3	7	28(8)	56(8)	
AAAP	Bridge Deck	560	640	0.45	—	3,000	4,000	—	4,000
AAA(3)	Other	634	752	0.43	—	3,600	4,500	—	4,000
AAAP LW	Bridge Deck	600	730	0.45	---	3,000	4,000	---	4,000
AA	Slip Form Paving	587	752	0.47	—	3,000	3,750	—	3,500
AA	Paving	587	752	0.47	—	3,000	3,750	—	3,500
AA	Accelerated(6)	587	800	0.47	—	—	3,750	—	3,500
AA	Structures and Misc.	587	752	0.47	—	3,000	3,750	—	3,500
AA LW		587	752	0.47	---	3,000	3,750	---	3,000
ASC(9)		587	846	0.47	---	---	4,000	---	4,000
A		564	752	0.50	—	2,750	3,300	—	3,000
C		394	658	0.66	—	1,500	2,000	—	2,000
HES		752	846	0.40	3,000	—	3,750	—	3,500

(1) Test Procedures: Slump—AASHTO T 119; Compressive Strength—PTM No. 604, or Maturity Meter Method—PTM No. 640. The upper age limit and lower age limit are defined by the values listed for 7-day and 28-day compressive strength.
(2) For use in miscellaneous or structural concrete, if the Fineness Modulus (FM) is between 2.3 and 2.5, increase the minimum cement factor for the class of concrete 47 pounds per cubic yard. This requirement may be waived after adequate strength data is available and analyzed according to the mix-design section in ACI 211.
(3) AAA concrete is not allowed to be used for new bridge decks.
(4) For exception, see Section 704.1(c). Cement factor may be increased to a maximum of 690 pounds per cubic yard with the approval of the DME/DMM.
(5) If a portion of the cement is replaced by SCM, use a water to cement plus SCM ratio by weight. The minimum water cement ratio for AAAP is 0.40 pounds per pounds.
(6) For accelerated cement concrete, submit mix design, as specified, Section 704.1(c), having a minimum target value compressive strength of 1,500 pounds per square inch at 7 hours if tested according to PTM No. 604. (1,500 pounds per square inch at 7 hours is for mix design acceptance only). The required compressive strength for opening to traffic is specified in Section 501.3(q).
(7) Trial Mix Designs for Class AAAP, AAAP LW, ASC and all concrete paving mixtures are required to meet a minimum 28-day compressive strength overdesign requirement of 28-day Minimum Mix Design Compressive Strength plus 500 pounds per square inch.
(8) DME/DMM may accept mix designs based on the 56-day strength based on qualification testing.
(9) For accelerated structural cement concrete, submit mix design, as specified in Section 704.1(c), having a minimum target value compressive strength of 3,500 pounds per square inch at 24 hours and 3,000 pounds per square inch to open to traffic when tested according to PTM No. 604.

1. Density of Material. Except for admixtures, use the following material densities (unit weights) if proportioning cement concrete:

Type of Material	**Density**
Water	62.4 pounds per cubic foot
Cement	94.0 pounds per cubic foot
Fine Aggregate	Based on bulk specific gravity as specified in Section 704.1(b)2
Coarse Aggregate	
Stone or Gravel	Based on bulk specific gravity as specified in Section 704.1(b)2
Slag	Based on field tests as specified in Section 704.1(b)2
Lightweight	Based on bulk specific gravity as specified in Section 704.1(b)2
SCM	Based on the LTS Tests

2. Specific Gravity of Aggregates. For fine and coarse aggregates, use the bulk specific gravity (saturated, surface-dry basis) listed in Bulletin 14.

For lightweight aggregate use the bulk specific gravity value (saturated surface-dry basis) listed in Bulletin 14, or the SSD gravity provided by the lightweight aggregate if purchased. As an alternative, the producer may run the SSD test and absorption with District Materials unit present.

If slag is used, test at the site to determine its loose-struck unit weight, solid volume per cubic yard, and bulk specific gravity factor (saturated surface-dry basis). Establish the concrete proportions based on the bulk specific gravity factor determined by the test. Check the unit weight of the slag daily to maintain the established solid-volume proportions.

3. Adjustment of Weight of Free Water. Adjust the batch weight of the aggregate to compensate for the free water on the aggregate. Base this adjustment on tests of representative samples taken from aggregate stockpiles.

4. Batching. For plant and truck mixed cement concrete, batch by weight. For volumetric mixed cement concrete, batch by volume.

(c) Design Basis.

1. General. Compute and prepare concrete mix designs according to ACI 211. For AAAP, determine the aggregate gradation for the mix design according to PTM No. 528. This does not apply to AAAP with #8's. Base concrete mix designs on the materials to be used in the work.

Overdesign strengths will be a minimum of 1,000 pounds per square inch except for AAAP, AAAP LW, AA Paving, and ASC which will be 500 pounds per square inch.

Make trial mixtures for each class of concrete and mold and cure test specimens. If the requirements of Table A cannot be achieved, furnish other acceptable materials or make necessary changes in the mixing procedure to conform to the specified requirements. Notify the DME/DMM at least 3 days in advance of preparing trial mixtures.

At the start of construction, mix a full-sized batch using the type of mixer and the mixing procedure planned for the project. Use this batch to provide the basis for final adjustment of the accepted design.

Mixture qualifications testing of Anti-Washout concrete according to PTM No. 641 to determine the maximum loss and required anti-washout admixture dosage may be conducted at an accredited lab or by the ready-mix producer with oversight from a technical representative from the admixture supplier. Trial batching for determination and verification of other design requirements must be performed by the ready-mix producer as specified in Section 704.1(c). Document the test results from the mixture qualification testing on the mix design before submitting for Department review.

2. Cement Factor. For all classes of concrete, use the minimum cement factor (cement, blended cement, or cement and SCM(s) combined) specified in Table A, except as follows:

Portland cement may be replaced with SCM(s) provided the maximum replacement by mass percentages in Table G, Prevention Level Z are not exceeded. The maximum limit of the cement factor may be waived if SCM(s) is/are added to the mix provided the portland cement portion does not exceed the maximum cement factor specified.

For AAAP and AAAP LW cement concrete, replace Type I or Type II portland cement with SCM (silica fume, flyash or slag cement) weighing as much as or more than the portland cement replaced. The percentages of SCM applicable to AAAP concrete are as shown below. Limit SCM to not more than two of the three SCMs listed below in one mix design as long as one of the SCM supplements meets the minimum percentage of replacement.

Cement factor must include at least one of the following as a replacement for a portion of the cement:

Slag Cement (Grade 100 or higher)	25% (min)
Flyash (Type C or Type F)	15% (min)
Silica Fume	5%-10%

3. Air Content. Design cement concrete to have an air content of 6.0% in the plastic state. Design AAAP and AA(pave) concrete mixes to have an air content of 7.0% in the plastic state. Obtain the air content through the addition of a solution of an air-entraining admixture as specified in Section 704.1(e)4. Use the quantity of air-entraining admixture necessary to maintain the plastic concrete air content, determined according to AASHTO T 152 (DO NOT APPLY AN AGGREGATE CORRECTION FACTOR) for stone and gravel and AASHTO T 196 (DO NOT APPLY AN AGGREGATE CORRECTION FACTOR for slag or lightweight coarse aggregate, within a tolerance of ± 1.5% during the work. The plastic concrete air content includes entrapped and entrained air.

If the hardened concrete exhibits deficiencies or the Representative suspects the hardened concrete to have deficiencies, and, if directed, determine the percent of entrained air in the hardened concrete according to PTM No. 623. Voids greater than 0.2 mils and less than 40 mils in their smallest dimension are considered entrained air. Voids 40 mils or more in diameter are considered entrapped air. The entrained air in the hardened concrete must be between 3.5% and 7.5%, inclusive. For AAAP and AA(pave) mixes, the entrained air in the hardened concrete must be between 4.5% and 8.5% inclusive.

4. Mix Design Acceptance. Submit a copy of each completed mix design to the Representative before its use in the work. The Department reserves the right to review all design through plant production before its use in Department work at no additional cost to the Department. The concrete design submitted for review is required to comply with the specified concrete class requirements, supported by slump, air content, and compressive strength test data according to ACI 211.

The Department will accept concrete designs based on the 7-day strength tests (Class High Early Strength (HES) may be accepted based on 3-day strength tests); however, conduct 28-day tests to show the potential of the design mix. The Department may also accept designs based on the 28-day tests.

Design AAAP cement concrete mixtures to achieve slow strength gain. Adjust component proportions with an objective of attaining a 28-day to 7-day compressive strength ratio during mix design greater than or equal to 1.20. A PennDOT inspector will witness the compressive strength tests. The 1.20 ratio is for mix design purposes only and not to be utilized as an acceptance factor during production. In no case will the Department accept any mixture during design which fails to meet a minimum 28-day to 7-day compressive strength ratio of 1.20.

Additional criteria for mix design acceptance of AAAP concrete are as follows:

The producer is required to complete the following tests before mix design submittal and approval.

- **Permeability** – Design the concrete mixture to meet a target chloride ion penetration of Low, Very low, or Negligible after a 56 day or less curing period according to AASHTO T 277 or AASHTO T 358.

  The DME/DMM has the option of accepting mix designs with a chloride ion penetration of Moderate, however, the chloride ion penetration must meet one of the following:

  AASHTO T 277, Table 1, not to exceed 2,800 coulombs; or

  AASHTO T 358, Table 1, not to exceed 15.6kΩ-cm for 4-inch by 8-inch cylinders and 12.3 kΩ-cm for 6-inch by 12-inch cylinders.

- **Shrinkage (Microstrain)** – The 28-day shrinkage according to ASTM C157 is not to exceed 500 microstrain unless approved up to 550 microstrains by the DME/DMM. Wet cure specimens in the lab for 14 days before beginning the 28-day shrinkage testing (42 total days).

If permeability and shrinkage testing have been met for AAAP with #57's, these tests are not required for AAAP with #8's, provided the aggregates are from the same source.

A higher-class concrete may be used in place of an indicated lower-class concrete if the higher-class concrete conforms to all the requirements of the indicated lower class, and if approved by the Department.

5. Lightweight Cement Concrete (AAAP LW and AA LW). Compute and prepare concrete mix designs according to ACI 211.2. Design lightweight cement concrete to have a range of Equilibrium Density of 110 pounds per cubic feet to 117 pounds per cubic feet with a target of 115 pounds per cubic feet, when tested according to ASTM C567

Supply the following information to the District Materials Unit at least two weeks before conducting trial mixes:

- Approximate absolute volume of coarse aggregate (cubic feet)
- Suggested coarse aggregate factor (CAF) (pounds per cubic yard)
- Oven-dry loose weight of coarse aggregate (pounds per cubic feet)
- Specific gravity factor
- Percent absorption

Store and use lightweight aggregates in a stable, uniform, saturated condition to ensure the aggregate, if batched, is at a moisture greater than saturated surface dry (SSD). Use the same source of aggregates and mix design throughout the entire project.

Plastic density can be used for field acceptance once a correlation between plastic density and equilibrium density is established. Equilibrium density as measured according to ASTM C567.

Entrained air content can be determined by the unit weight method according to ASTM C138. Once established, a correlation between air content as tested according to ASTM C 173 and the unit weight method can be made.

6. Sulfate Resistance Concrete. Design sulfate resistant concrete according to ACI 201.2.

(d) Testing and Acceptance.

1. QC Plan. Prepare a QC Plan as specified in Section 106.03 and submit it for review before the start of the project and at least annually thereafter. Include in the QC Plan testing frequencies and action points to initiate corrective measures. Do not start work until the Department has reviewed the QC Plan. Furnish a copy of the QC Plan to be maintained in the Department's project field office.

1.a Field Operation QC Plan. Prepare a field operation QC Plan for the Representative's review, on Form CS-704, to evaluate concrete field operation. Submit the field operation QC Plan at the Pre-construction conference or at least 3 weeks before the first concrete pour. Describe the construction equipment, personnel, and methods necessary to construct and test concrete courses for all structural elements. Include testing frequencies and action points to initiate corrective measures. Do not establish action points at either the upper or lower specification limits.

2. Concrete Technician. Provide, and assign to the work, a concrete technician properly instructed and trained to develop the concrete design, to control the quality and gradation of aggregates used, to perform required concrete tests, and to control the operations and concrete deliveries so the completed mixture conforms to the specifications at the point of placement.

The Department's concrete plant Inspector will not allow concrete considered unacceptable to be shipped to the project. The Inspector will not assume, by act or by word, any responsibility for batch control adjustments; calculations; or for setting of dials, gauges, scales, or meters. Failure of the Inspector to reject unacceptable concrete will not relieve the Contractor's obligation to provide concrete conforming to the specifications.

2.a Concrete Field Testing Technician. Provide, and assign to the work during placement of material, a PennDOT certified field testing technician, meeting the requirements according to Publication 536, to perform the required acceptance testing. The technician must carry a valid PennDOT certification card during placement of material.

2.b. Concrete Finisher Certification. Provide ACI certified Flatwork Finishers, ACI certified Advanced Flatwork Finishers, or National Ready-Mix Concrete Association (NRMCA) certified Exterior Flatwork Finishers to control finishing of each concrete placement operation for all concrete finishing work associated with the following Sections:

501 502 505 506 516 518

519	520	523	525	527	530
540	545	548	623	630	633
640	641	658	676	695	852
910	1001	1040	1042	1090	

A minimum of 60 percent of the finishers finishing concrete on each concrete placement must possess at least one of the identified flatwork finisher certification types, unless approved by the Representative. Provide proof of flatwork finisher certification to the Representative before concrete placement.

3. Testing Facilities and Equipment. Provide sufficient thermometers, air meters conforming to AASHTO T 196 and T 152, and slump cones conforming to AASHTO T 119 for each separate project operation as needed. In the presence of the Inspector, calibrate all air meters a maximum 2 weeks before beginning concrete placement. Recalibrate all air meters, in the presence of the Inspector, every 2 weeks during concrete placement. Have back-up equipment available to ensure no tests are missed. Provide sufficient 6-inch by 12-inch cylinder molds and tight-fitting domed caps (PTM No. 611) for QC, acceptance, verification, and QA samples. Provide sufficient incidental equipment such as wheelbarrows, shovels, and scoops as needed.

Provide acceptable means to conduct compressive strength testing using a compression machine and capping device conforming to PTM No. 604. Provide a curing tank conforming to PTM No. 611. Provide curing boxes, or other acceptable equipment, conforming to PTM No. 611 and capable of maintaining the air temperature immediately adjacent to the field-cured cylinders in the range of 60F to 80F for the first 24 ± 2 hours. Provide sufficient high-low thermometers or other temperature recording devices to monitor the temperatures next to the test cylinders. If required, cap cylinders at the testing site under the Representative's supervision.

If using the maturity method to estimate concrete compressive strength, provide one or more maturity meters and a sufficient number of temperature sensors conforming to PTM No. 640. Note: Casting concrete cylinders according to PTM 611 is recommended in case maturity meter equipment malfunctions.

Maintain all equipment used for testing in an operable condition. Using an independent agency acceptable to the Department, calibrate scales, balances, and the compression machine at least once per year. Recalibrate the compression machine whenever it is relocated. Maintain accurate records of calibration. If the compression machine is out of tolerance or malfunctions, return it to working order within 24 hours or supply a back-up machine until the problem is corrected.

Provide the necessary facilities for inspection, including a plant office as specified in Section 714.5(a), with the exception of a minimum floor space of 120 square feet.

4. QC Testing. Perform QC testing according to the reviewed QC Plan and as follows:

4.a QC Sampling and Testing of Plastic Concrete. Select an appropriate slump target value and range that will provide a workable mix for the construction element. The Contractor's technician must have a copy of the Department reviewed QC Plan in their possession during testing and must be aware of the target slump for the structural element being placed. Do not exceed the following slump upper limits:

Type of Mix	**Slump Upper Limit**
without water reducing admixtures	5 inches
with water reducing admixtures	6 1/2 inches
with high range water reducing admixtures (superplasticizers)	8 inches
mixes specified in Section 704.1(h) (except tremie concrete as specified in Section 1001.2(j))	2 1/2 inches
AAAP (regardless of admixtures used)	5 1/2 inches
AAAP LW (regardless of admixtures used)	6 inches

Perform plastic concrete slump, air, density (for AAAP LW and AA LW) and temperature tests on the first three consecutive trucks at the beginning of concrete placement operations or after a significant stoppage such as plant or equipment breakdown to determine if material control has been established. Material control is established when all test results of concrete slump, air, and temperature for three consecutive trucks are determined to be within the established action points. Obtain samples of fresh concrete according to PTM No. 601. Perform slump tests according to AASHTO T 119, air content tests according to AASHTO T 152 (DO NOT APPLY AN AGGREGATE CORRECTION FACTOR) or T 196 (DO NOT APPLY AN AGGREGATE CORRECTION FACTOR) (AASHTO T196 for AAAP LW and AA LW), temperature tests according to ASTM C1064, and density testing according to

AASHTO T 121(for AAAP LW and AA LW) Report test data to the concrete technician promptly in order to facilitate necessary changes. Continue testing consecutive trucks until material control is established. Once material control is established, the frequency of testing may be reduced to a minimum of one test per 50 cubic yards. Select concrete batches for sampling according to the reviewed QC Plan or as directed by the Inspector. Notify the Inspector if sampling and QC testing are to be performed. The Inspector will witness the sampling and QC testing. If a QC test fails to conform to the specified requirements or exceeds the upper or lower action points included in the reviewed QC Plan, increase the testing frequency to every truck until material control has been reestablished.

Maintain the cement concrete consistency within 1 1/2 inches of the selected target slump value (target range). If the upper slump limit is exceeded on any slump test, the Contractor's technician shall reject the cement concrete. If any slump test result falls outside the target range and has not exceeded the upper limit, immediately perform the air content and temperature tests. If the air content and concrete temperature is within the specified limits, the Contractor may incorporate the material into the work provided a full set of quality control and acceptance cylinders are molded in addition to the cylinders made for the originally selected PTM No. 1 sample location, for compressive strength testing according to PTM No. 611 and PTM No. 604. If one or more truckloads of cement concrete exceeds the slump target range, make additional quality control and acceptance cylinders from each truck. Use the lowest compressive strength cylinders for acceptance of the lot.

Do not incorporate concrete into the work that does not conform to the specified requirements.

4.b QC Compressive Strength Test Cylinders. From the same sample of concrete selected for acceptance testing as specified in Section 704.1(d)5, mold a sufficient number of concrete QC cylinders to be tested for 3-day or 7-day compressive strength, 14-day compressive strength (AAAP), 28-day compressive strength, form removal strength, and loading strengths, as specified.

If using the maturity method to estimate concrete compressive strength, mold two or more cylindrical specimens for temperature history recording and embed a temperature sensor at the vertical and horizontal center of the cylindrical specimen and activate the maturity meter or data acquisition equipment to record the temperature history for the 3-day, 7-day, 14-day (AAAP), 28-day, and, as required, 56-day compressive strength analysis.

Field cure cylinders according to PTM No. 611, Section 11.2, for the specified curing period. After concrete curing is discontinued, QC cylinders may be relocated to a preapproved, acceptable, secure area, to protect them from damage. Provide maintenance and security for the area at no additional cost to the Department. The secure area must be easily accessible for inspection at all times. Continue to provide the same field cure and protection from the elements on all surfaces of the cylinders as that provided for the in-place concrete the cylinders represent until the cylinders are tested for compressive strength. Remove cylinders from molds at the same time formwork is removed.

Perform QC testing for 3-day or 7-day compressive strength, 14-day compressive strength (AAAP), 28-day compressive strength, and form removal and loading strengths according to PTM No. 611. If using the maturity method to estimate concrete compressive strength, perform QC testing using the procedure to estimate in place strength according to PTM No. 640. Do not use the maturity method for determining acceptance strength, typically at 28 days. Notify the Inspector when QC testing is to be performed. The Inspector will witness the QC testing.

Unless otherwise directed, use QC test results for 3-day or 7-day compressive strength and form removal and loading compressive strength to determine whether to place additional concrete in areas that will be impacted by the lot of concrete represented by the QC cylinders. Acceptable QC compressive strength test results do not relieve the Contractor's responsibility for providing concrete conforming to the 28-day minimum mix design compressive strength acceptance requirements as specified in Section 704.1(d)5.

For AAAP and Prevention Level Z mixes, in addition to the samples required above, mold two concrete cylinders and cure them under QC conditions for 56 days. After 56 days test the two cylinders for compressive strength and report the compressive strengths.

4.b.1 3-Day or 7-Day or 14-Day (AAAP) QC Compressive Strength. If the average 3-day (HES concrete only) or average 7-day QC compressive strength test result is greater than or equal to the minimum mix design compressive strength requirement specified in Table A, the Contractor may discontinue the field cure on the lot of concrete represented by the QC cylinders unless otherwise directed. If the average 14-day (AAAP) QC compressive strength test result is greater than or equal to 3,500 pounds per square inch, the Contractor may discontinue the field cure on the lot of concrete represented by the QC cylinders, unless otherwise directed.

If the average 3-day (HES concrete only) or average 7-day QC compressive strength test result is less than the minimum mix design compressive strength requirement specified in Table A, continue the field cure on the lot of concrete represented by the QC cylinders until the specified 28-day minimum mix design compressive strength is obtained, or for a maximum of 28 days. If the average14-day (AAAP) QC compressive strength test result is less than 3,500 pounds per square inch, continue the field cure on the lot of concrete represented by the QC cylinders, until the specified 28-day minimum mix design compressive strength is obtained, or for a maximum of 28 days.

4.b.2 28-Day QC Compressive Strength. If the average 28-day QC compressive strength test result is greater than or equal to the 28-day minimum mix design compressive strength specified in Table A, acceptance of the concrete lot will be based on the compressive strength testing of acceptance cylinders as specified in Section 704.1(d)5.

If the average 28-day QC compressive strength test result is less than the 28-day minimum mix design compressive strength specified in Table A, but greater than or equal to the 28-day structural design compressive strength specified in Table A, acceptance of the concrete lot will be based on the compressive strength testing of acceptance cylinders as specified in Section 704.1(d)5, and as follows:

- Perform an investigation of procedures for material sampling, testing, and concrete cylinder molding and curing, and evaluate the concrete mix design and specification compliance to determine possible causes for the QC test result not meeting the specified minimum mix design compressive strength.
- Implement corrective actions as required.
- Submit an investigation report to the District Executive within 10 working days for review and approval.

If the average 28-day QC compressive strength test result is less than the 28-day structural design compressive strength specified in Table A, acceptance of the concrete lot will be based on compressive strength testing of cores obtained from the lot of concrete represented by the QC cylinders as specified in Section 110.10(d).

5. Acceptance Testing. Determine the lot size(s) for material acceptance according to Table B and notify the Representative. Establish new lots daily for each class of concrete. Lots must be specific to a particular structural element, except for incidental concrete items. The Contractor may use a lot combining structural elements if allowed in writing before concrete placement and if the following conditions are met:

- The total volume is 100 cubic yards or less.
- The combined structural elements are constructed using the same mix design concrete.
- The combined structural elements are cured using identical curing methods and conditions.

Cylinders (and cores if necessary) for this lot will represent all the combined elements.

TABLE B
Maximum Lot Size for Concrete Acceptance

Construction Area	Maximum Lot Size
Structural Concrete	100 cu. yd.
Pavement Concrete	500 cu. yd.
Pavement Patching Concrete	200 cu. yd.
Incidental Concrete	100 cu. yd.

The Representative will select sample locations for acceptance testing according to PTM No. 1 (n=1). Perform sampling and testing for acceptance in the presence of the Representative. Obtain samples of fresh concrete at the point of placement according to PTM No. 601. Perform concrete temperature tests. Perform air content tests according to AASHTO T 196 or T 152. Reject all concrete not conforming to the specification requirements at the point of placement.

If the results of plastic concrete testing conform to the specification requirements, mold a sufficient number of acceptance cylinders according to PTM No. 611 from the same sample of concrete taken for slump, air content, and temperature determination. Standard cure acceptance cylinders according to PTM No. 611, Section 11.1, for 28 days and 56 days (AAAP and Prevention Level Z) at an acceptable location. Conduct 28-day and 56-day (AAAP and Prevention Level Z mixtures only) compressive strength testing of two acceptance cylinders according to PTM No.

604. If for any reason two testable acceptance cylinders are not available for compressive strength testing, obtain two cores of the representative concrete within 3 working days as directed, and at no additional cost to the Department. Conduct 28-day compressive strength testing of the cores according to PTM No. 604.

The Department will accept the lot of concrete if the average 28-day acceptance cylinder compressive strength test result is greater than or equal to the 28-day minimum mix design compressive strength specified in Table A and if the average 28-day QC compressive strength requirements specified in Section 704.1(d)4.b have been met.

If the average 28-day acceptance cylinder compressive strength test result is less than the 28-day minimum mix design compressive strength specified in Table A, acceptance of the concrete lot will be based on the procedures as specified in Section 110.10.

6. Verification Testing. The Representative will perform verification testing on the initial acceptance sample for each type of concrete specified in Table B and a minimum of one verification test for every ten acceptance samples thereafter. Verification testing will consist of testing for temperature, air content, and compressive strength. Verification tests will be performed on concrete from the same sample used for acceptance testing.

The Representative will obtain the temperature of the sample concurrently with the acceptance sample. Immediately after an acceptable air content test result for acceptance is obtained, the Representative will test the sample for air content according to AASHTO T 196 or T 152 using the same air meter.

The Representative will mold two verification cylinders according to PTM No. 611. Standard cure the verification cylinders along with the acceptance cylinders according to PTM No. 611, Section 11.1, for 28 days. The Representative will conduct 28-day compressive strength testing of the verification cylinders according to PTM No. 604. Conduct the testing at the same time the acceptance cylinders are tested and using the same equipment.

Verification test results will be compared to the associated acceptance test results and will not be used to determine acceptance of the lot. If there is a difference in test results of more than 5F for temperature, 1.0% for air content, or 500 pounds per square inch for compressive strength, the Representative will immediately review the testing procedures, equipment, and personnel used in the acceptance testing and implement corrective measures to ensure the tests are performed within the prescribed tolerances. The Representative will record the acceptance test results, the verification test results and applicable corrective measures in the Concrete Inspector's Daily Record Book, Form CS-472.

7. QA Testing. The CMD QA personnel will obtain QA samples as part of the operation review process according to the QA Manual, Publication 25.

QA personnel will select concrete to be sampled. Obtain samples of fresh concrete at the point of placement according to PTM No. 601. Perform concrete temperature tests adjacent to those conducted by QA personnel. Perform air content tests according to AASHTO T 196 or T 152 with the air meter used for acceptance testing. QA personnel will perform air content tests according to AASHTO T 196 or T 152 with the backup air meter on the project. Immediately report all test results to the QA personnel. Reject all concrete not conforming to the specification requirements at the point of placement.

QA personnel will immediately perform an independent assurance evaluation of the temperature and air content test results. If the difference in test results is more than 5F for temperature or 1.0% for air content, the Representative will immediately review the testing procedures, equipment, and personnel used in the acceptance testing and implement corrective measures to ensure the tests are performed within the prescribed tolerances.

QA personnel will mold five QA cylinders from the selected sample according to PTM No. 611. Field cure the QA cylinders according to PTM No. 611, Section 11.2, for the specified curing period for the structural element the cylinders represent. After curing of the in-place concrete is discontinued, QA cylinders may be relocated to a pre-approved, acceptable, secure area, to protect them from damage. Provide maintenance and security for the area at no additional cost to the Department. The secure area must be easily accessible for inspection at all times. Continue to provide the same field cure and protection from the elements on all surfaces of the cylinders as that provided for the in-place concrete the cylinders represent until the cylinders are tested for 28-day compressive strength.

Conduct 28-day compressive strength testing on two QA cylinders according to PTM No. 604 using the same equipment used for acceptance and verification testing.

The Representative will forward the remaining three QA cylinders to the LTS for 28-day compressive strength testing according to PTM No. 604 and hardened air content testing according to PTM No. 623. Furnish packaging material and package cylinders under the direction and supervision of the Representative. Place the cylinders in individual containers cushioned with suitable material to prevent damage during shipment. The total weight of each container, cylinder and cushioning material must not exceed 50 pounds.

QA personnel will perform an independent assurance evaluation of the 28-day compressive strength test results. If the difference between the test results of the cylinders tested at the project site and the cylinders tested at the LTS is more than 500 pounds per square inch, the Representative will immediately review the testing procedures, equipment, and personnel used in the acceptance testing and implement corrective measures to ensure the tests are performed within the prescribed tolerances.

(e) Measurement of Material.

1. Cement. AASHTO M 157 and as follows:

For plant and truck mixed concrete, measure by weight. The Contractor may measure the weight of the cement separately in an enclosed compartment in the aggregate hopper. The Contractor may measure the weight of the cement and discharge it simultaneously with the aggregates, except as specified in Section 106.05(c).

For volumetric mixed concrete, measure by volume.

2. Aggregates. AASHTO M 157 and as follows:

For plant or truck mixed concrete, measure by weight unless otherwise allowed. Base measurements on the material weight-volume relationship, as specified in Section 704.1(b)1.

For volumetric mixed concrete, measure by volume.

3. Water. AASHTO M 157 except as follows:

Use water-measuring systems capable of discharging the total quantity of measured water into the plant or truck mixer drum in a time not greater than one-fourth of the specified mixing time. For truck mixed concrete, do not add water from the truck water system. Add water only from the plant water measuring system.

4. Admixtures. Incorporate the air-entraining admixture solution into the batch with the mixing water using a suitable visual measuring device. If another type of admixture is used with an air-entraining admixture, add it in solution to another portion of the mix water, as directed, by an additional suitable visual measuring device, except high range water reducing and anti-washout admixtures will be added according to the manufacturer’s recommendations.

Equip the measuring device with interlocks to prevent discharging during the charge cycle and to prevent charging during the discharging cycle. Provide a means to calibrate the measuring device to within ±3%.

Dispense the air-entraining admixture solution into the batch from a bulk supply tank. For paving, and if directed, provide a bulk supply tank containing sufficient solution for the entire day's concreting operations.

On the dispensing system, provide device(s) capable of detecting and indicating the presence or absence of admixture flow. Agitate admixtures, as required, to insure consistency of the solution.

5. SCM. If the use of SCM is allowed by the specification, add separately and measure cumulatively as specified in Section 704.1(e)1.

(f) Mixing Conditions.

1. During Cool and Cold Weather. If concrete is to be placed at air temperatures below 40F, or if the local weather bureau forecasts air temperatures to descend to 40F or lower at any time during the 24-hour period following concrete placement, use an acceptable method to ensure the aggregate is free of frozen lumps and at a temperature of not less than 40F or more than 100F at the time of charging into the mixer. Heat mixing water, if necessary, but do not exceed 150F. Do not allow water with a temperature above 90F to come in contact with the cement until the cement has been mixed with the aggregates.

2. During Hot Weather. In hot weather, cool the aggregates and the mixing water as necessary to maintain the concrete temperature from 50F to 90F at the time of placement. For bridge deck concrete placement, maintain the concrete temperature from 50F to 80F at the time of placement. For accelerated concrete placement, maintain the concrete temperature from 50F to 100F at the time of placement.

3. Retarding Admixtures. The Contractor may use retarding admixtures, or may be directed to use retarding admixtures, if any of the following conditions are anticipated:

- rapid drying of the concrete as a result of low humidity
- high winds

- high air temperatures

Introduce the retarder into the concrete mixture as specified in Section 704.1(e)4. Adjust the proportions of the design as necessary but do not use the retarder to replace any portion of the specified volume of cement.

Use a retarder available in sufficient quantities to provide the required degree of retardation under the prevailing weather conditions at the time of concrete placement.

(g) Mix Designs Using Potentially Reactive Aggregate.

1. Definition of Terms.

1.a Alkalis. Oxides of sodium and potassium generally derived from Portland cement, but may also be available to concrete from other sources such as; admixtures, de-icing salts, and, in rare instances, aggregates. Alkalis are calculated according to AASHTO M 85.

1.b SCM. A siliceous or siliceous and aluminous material that possesses little or no cementitious value but will, in finely divided form and in the presence of moisture, chemically react with calcium hydroxide at ordinary temperatures to form compounds possessing cementitious properties. The term "SCM," includes flyash, slag cement, silica fume, and metakaolin.

1.c **Lithium Nitrate Admixtures.** A lithium nitrate admixture as listed in Bulletin 15.

1.d Alkali-Aggregate Reaction. A chemical reaction in concrete between alkalis and certain constituents of some aggregates. The products of this reaction, under certain conditions, may cause deleterious expansion within the concrete.

1.e Alkali-Silica Reaction. An alkali-aggregate reaction involving certain siliceous aggregates and some calcareous aggregates containing certain forms of silica.[(1)]

Note (1)—Siliceous substances known to react with alkalis are as follows: opal; chalcedony as a constituent of chert in carbonate rock or sand and gravel particles; tridymite and cristobalite, which are high temperature forms of silica found in andesite or rhyolite; acid glasses containing more than 65% silica; or intermediate glasses containing between 55% and 65% silica. Other siliceous substances that are potentially reactive with alkalis are strained quartz as a constituent of granite or granite gneiss and clay minerals as a constituent of graywackes, argillites, phyllites, and siltstones.

1.e.1. Determining Aggregate Reactivity.

1.e.1.a. Field Performance History. Field performance history according to AASHTO R 80, Section 6.1 of an aggregate may be used to establish the potential to contribute to deleterious ASR with the approval of the DME/DMM.

1.e.1.b Petrographic Examination. Petrography may be used to classify an aggregate as potentially reactive, but expansion testing is required to determine the extent of potential reactivity and the appropriate level of prevention.

1.e.1.c. Expansion Testing. Aggregates will be tested according to ASTM C1293 or AASHTO T 303 and listed in Bulletin 14. ASTM C1293 test results will be used to determine the reactivity level of an aggregate. Unless it is a new source, the AASTHO T 303 results will be used until ASTM C1293 testing is completed by the Department. The reactivity class of the aggregate will be used to determine the required level of prevention. If using aggregates with different reactivity levels, the highest reactivity level will be used for mitigation. If the expansion result for a coarse aggregate size is not listed in Bulletin 14, use of the expansion result from another coarse aggregate size listed in Bulletin 14 from the same source will be acceptable.

Use aggregates deemed potentially reactive only with cements or cement-SCM combinations as specified in Section 704.1(g)3. If one or both of the aggregates (coarse or fine) used in a mix is reactive, mitigation is required as specified in Section 704.1(g)3. This requirement applies to all concrete used in paving or permanent structures on Department projects, including latex modified overlays and precast and prestress concrete products.

For new Type A aggregate sources which do not have LTS expansion listed, LTS will initially perform AASHTO T 303 to determine the reactivity class. Any new source with an expansion that indicates the aggregate is non-reactive (R0) will initially be listed with an expansion of 0.11% (R1) requiring ASR mitigation until ASTM C1293 testing by LTS is completed.

Sources will be tested on a 5-year cycle according to ASTM C1293. Testing will be performed by LTS. If the new test results change the mitigation level of the aggregates, mix designs must be started immediately and all designs must be completed within 90 days of receiving test results.

2. Selecting Preventive Measures for Alkali-Silica Reaction.

2.a Using the Concrete Prism Test (ASTM C1293) to Evaluate Preventive Measures.

2.a.1 Mixture Qualification. The concrete prism test may be used to evaluate the efficacy of SCMs or blended cements or both used with volumetric SCM replacements less than those specified in Section 704.1(g)2.c as a prescriptive remediation method and for all mixtures utilizing remediation with either metakaolin or a lithium nitrate admixture. If lithium nitrate admixtures are used, the admixture must be added to the mix water and necessary corrections made to account for the water in the admixture. If the expansion of concrete prisms is less than 0.04 percent after 2 years, the preventive measure will be deemed effective with the reactive aggregate(s).

For mixtures qualified using the preventive measure, substitutions of the cement (type for type), or SCM(s), type for type will be allowed provided the alkali limits as specified in Section 704.1(g)3 are not exceeded. Substitution of aggregates using the preventive measure is prohibited.

2.b Steps for Selecting Preventive Measures for Alkali Silica Reaction.

2.b.1 Determine the level of prevention by considering the reactivity class of the aggregate(s), classification of the structure type, and the associated risk level.

2.b.1.a Aggregate Reactivity. The degree of alkali silica reactivity of an aggregate will be determined as specified in Section 704.1(g).1.d.1.c and as indicated in Table C.

Table C
Classification of Aggregate Reactivity

Aggregate Reactivity Class	Description of Aggregate Reactivity	1-Year Expansion in ASTM C1293 (percent)	14-d Expansion in AASHTO T 303 (percent)
R0	Non-reactive	≤ 0.04	≤ 0.10
R1	Moderately reactive	>0.04 to ≤ 0.12	>0.10 to ≤ 0.30
R2	Highly Reactive	>0.12 to ≤0.24	>0.30 to ≤0.45
R3	Very Highly Reactive	>0.24	>0.45

2.b.1.b Risk of ASR. Determine the level of ASR risk occurring in a structure by considering the aggregate reactivity class in Table D.

Table D
Level of ASR Risk

Aggregate Reactivity Class	R0	R1	R2	R3
Level of ASR Risk	Risk Level 1	Risk Level 2	Risk Level 3	Risk Level 4

2.b.1.c Level of Prevention. The level of prevention is determined from Table E by determining the risk of ASR from Table D together with the class of structure from Table F.

Table E
Determining the Level of Prevention

Level of ASR Risk	Classification of Structure		
	S1	S2	S3
Risk Level 1	V	V	V
Risk Level 2	V	W	X
Risk Level 3	W	X	Y
Risk Level 4	X	Y	Z

Table F
Structure Classification

Structure Class	Consequences	Acceptability of ASR	Structure/Asset Type	Sections
S1	Safety and future maintenance consequences small or negligible	Some deterioration from ASR may be tolerated	Temporary structures. Inside buildings. Structures or assets that will never be exposed to water	620, 621, 624, 627, 628 643, 644, 859, 874, 930, 932, 934, 952, 953, and 1005
S2	Some minor safety, future maintenance consequences if major deterioration were to occur	Moderate risk of ASR acceptable	Sidewalks, curbs and gutters, inlet tops, concrete barrier and parapet. Typically structures with service lives of less than 40 years	303, 501, 505, 506, 516, 518, 523, 524, 525, 528, 540, 545, 605,607, 615, 618, 623, 630, 633, 640, 641, 658, 667, 673, 674, 675, 676, 678, 714, 852, 875, 910, 948, 951, 1001, 1025, 1040, 1042, 1043, 1086, 1201, 1210, 1230, and Miscellaneous Precast Concrete
S3	Significant safety and future maintenance or replacement consequences if major deterioration were to occur	Minimal risk of ASR acceptable	All other structures. Service lives of 40 to 75 years anticipated.	530, 1001, 1006, 1031, 1032, 1040, 1080, 1085, 1107, MSE walls, Concrete Bridge components, and Arch Structures

2.c Minimum Levels of Supplementary Cementitious Materials (SCM) based on Level of Prevention. Utilize a minimum mass replacement level from Table G below.

Table G
Minimum Replacement Level of SCM (percentage by mass of cementitious material [12])

Type of SCM[1]	Alkali Level of SCM (% Na2Oe) [2], [3]	Level V[4]	Level W	Level X	Level Y	Level Z[5], [11]
Class F or C flyash[6]	≤ 3.0	–	15	20	25	35
Class F or C flyash[6]	>3.0 to ≤ 4.5	–	20	25	30	40
Slag Cement	≤ 1.0	–	25	35	50	65
Silica Fume[7], [8], [9], [10]	≤ 1.0	–	1.2 x LBA	1.5 x LBA	1.8 x LBA	2.4 x LBA

Notes:

(1) The SCM may be added directly to the mixture, be a blended cement, or a combination of a blended cement and a SCM.
(2) Where combinations of Class C and Class F are used, the alkalinity of the Class C flyash may exceed 4.5% provided the calculated alkalinity of the combination, based on the mass replacement, does not exceed 4.5%
(3) If two or more SCMs (including SCMs in blended cements) are used in combination, the minimum mass replacement levels given in Table G for the individual SCMs may be reduced provided the sum of the parts of each SCM is greater than or equal to one. For example, if silica fume and slag are used together, the silica fume level may be reduced to one-third of the minimum silica fume level given in the table provided the slag level is at least two-thirds of the minimum slag level required.
(4) No remediation is required at prevention Level V unless otherwise indicated by specification, e.g. Section 530.
(5) The alkali level of the concrete may be limited as specified in Section 704.1(g) 2.c.1
(6) The CaO must be limited to a maximum of 18%.
(7) The SiO must be greater than or equal to 85%
(8) The minimum level of silica fume is calculated based on the alkali (Na2Oe) content of the concrete contributed by the Portland cement and expressed in LBA (lbs./cy) by multiplying the cement content of the concrete in lbs./cy by the alkali content of the cement divided by 100. For example, for a concrete containing 500 lbs./cy with an alkali content of 0.81% Na2Oe, the value of LBA = 500 x 0.81/100 = 4.05 lbs./cy. For this concrete, the minimum replacement level of silica fume for Level Y is 1.8 x 4.05 = 7.3 percent.
(9) Regardless of the calculated value, the minimum level of silica fume should not be less than 7 percent if it is the only method of prevention.
(10) It is impractical to modify a mix design frequently during production based on the actual alkali limit of the cement used, therefore, where silica fume is used as the sole method of prevention, the maximum assumed alkali limit of the cement must be indicated on the mix design.
(11) Additional options for prevention Level Z are specified in Section 704.1(g)2.c.1 and Table H
(12) The use of high levels of SCMs in concrete may increase the risk of problems due to deicer salt scaling if the concrete is not properly proportioned, finished, and cured.

2.c.1 The minimum replacement levels in Table G are appropriate for use with portland cements of moderate to high alkali contents (0.70 to 1.25 percent Na2Oe). Table H provides an alternative approach for utilizing SCMs if the alkali content of the Portland cement is less than or equal to 0.70%.

Table H
Adjusting the Minimum Level of SCM if using low alkali Portland cement

Cement Alkalis (% Na2Oe)	Level of SCM
≤ 0.70	Reduce the minimum amount of SCM given in Table G by one prevention level.(1)
(1) The replacement levels should not be below those given in Table G for prevention Level W regardless of the alkali content of the Portland cement.	

2.c.2 Requirements for Prevention Level Z. Where prevention Level Z is required, use the minimum level of SCM shown in Table G or use the minimum level of SCM and the maximum concrete alkali content indicated in Table I.

Table I
Using SCM and Limiting the Alkali Content of the Concrete

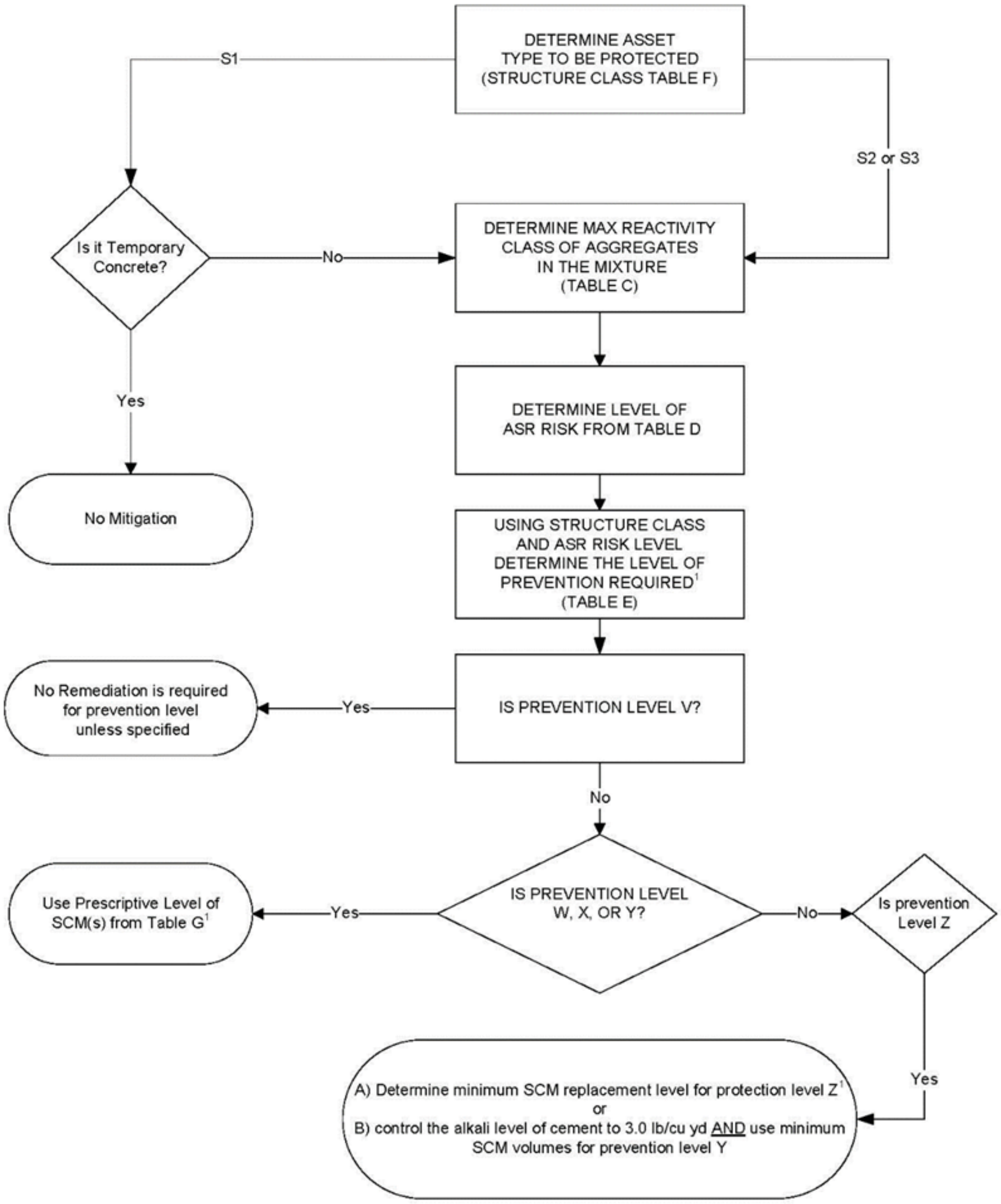
Prevention Level	SCM as sole prevention	Maximum Alkali Content, (lbs./cy) and Minimum SCM Level
Z	Level Z from Table G	Maximum Alkali Level Content: 3.0 AND minimum SCM Level Y from Table G

3. Cement/Cement-SCM Requirements. For use with aggregate deemed potentially reactive as specified in Section 704.1(g), provide Portland cement, blended hydraulic cement, or Portland cement-SCM combinations as specified in Section 704.1(b) and the following:

3.a Portland Cement. Conforming to the optional chemical requirement in AASHTO M 85 for a maximum alkali content of 1.25% Na2Oe if used for ASR prevention.

3.b Blended Hydraulic Cement. Type IS or IP, AASHTO M 240 (ASTM C595). From a manufacturer listed in Bulletin 15.

3.c. ASR Mitigation Flowchart.



Note 1: The prevention level may be reduced by one level if low alkali cement (≤ 0.70) is used.

4. **Admixture Requirements.** Furnish chemical admixtures as specified in Section 711.3.

5. **Exceptions.** If a service record of nonreactivity can be documented, the Department may exempt aggregates

classified through testing as potentially reactive, as specified in Section 704.1(g)2, from the cement/cement-SCM requirements as specified in Section 704.1(g)3.c. The service record must include a minimum of 10 structures, each over 10 years of age and preferably over 15 years of age.

Include the following documentation in the service record:

- A report on the visual examination of each structure for cracking including expansion at joints where applicable.
- Structure type and age.
- Concrete class or mix design proportions if available.
- Cement and alkali content of the cement used during construction.
- Use and type of all SCMs used in the mixture/structure.
- Presence and type of symptoms of distress if found.

Take cores from a representative number of structures and perform petrographic analysis of cores according to ASTM C856 to determine the presence or absence of alkali-silica gel formations and associated microcracking.

Determination of the aggregate classification according to ASTM C295. This analysis must confirm the aggregates from the structures are similar in mineralogical composition to that of the aggregate currently being considered for use.

If field performance history and subsequent testing indicates an aggregate source has begun to form ASR expansion, no exception for use other than the prescriptive methods provided will be accepted.

(h) Extra Cement Concrete. If 25% extra cement is allowed rather than the standard use of an anti-washout admixture (AWA) as specified in Section 1001.3(k)3.a, the extra cement may be replaced with other cementitious material in the same proportions as established in the mix design or as specified in Section 704.1(c). Up to 50% of the water dose for the extra cementitious material, based on the water cement ratio of the mix being utilized, may be added. Add additional admixtures, other than an AWA, as required for performance or to meet other mixture criteria as specified.

704.2 PLANT AND TRUCK MIXED CEMENT CONCRETE—

(a) Batching Plant. Proportion cement, aggregates, water, and admixtures in a plant conforming to AASHTO M 157 for batching plants.

Install a moisture meter to accurately and continuously indicate the variability of the fine aggregate moisture content. If approved, automatic moisture compensating probes for fine and coarse aggregate may be used to control the amount of batched water. Calibrate moisture probes according to the reviewed QC Plan.

Provide scales with graduation increments no greater than 1/1000 of the total scale capacity to measure the weight of aggregates or cement. Increments of less than 5 pounds are not required. Provide scales with capacities approximately equal to the hopper capacity or the central mixer capacity under normal proportioning conditions.

Provide a minimum of ten 50-pound weights at the plant for checking the scale's accuracy. Store the weights in a manner to maintain their weight-calibration accuracy.

Check the accuracy of the bin scales according to PTM No. 410.

Provide the plant with the following equipment for developing the concrete design and to control the quality of aggregates used and the concrete produced:

Number of Each	Equipment
1	Sample splitter for fine aggregate having an even number of equal width chutes that discharge alternately to each side of the splitter. A minimum of 12 total chutes is required. The minimum width of the individual chutes is to be at least 50% larger than the largest particles in the sample and the maximum width of the individual chutes is to be 3/4 inch. Include two receptacles to hold the samples following splitting. Splitter design must allow samples to flow smoothly without restriction or loss of material.
1	Sample splitter for coarse aggregate having an even number of equal width chutes that discharge alternately to each side of the splitter. A minimum of eight total chutes is required. The minimum width of the individual chutes is to be at least 50% larger than the largest particles in the sample. Include two receptacles to hold the samples following

	splitting. Splitter design must allow samples to flow smoothly without restriction or loss of material.
	Or
1	Adjustable sample splitter for both coarse aggregate and fine aggregate having an even number of equal width chutes that discharge alternately to each side of the splitter. A minimum of 12 total chutes is required. For coarse aggregate, the minimum width of the individual chutes is to be at least 50% larger than the largest particles in the sample. For fine aggregate, the minimum width of the individual chutes is to be at least 50% larger than the largest particles in the sample and the maximum width of the individual chutes is to be 3/4 inch. Include two receptacles to hold the samples following splitting. Splitter design must allow samples to flow smoothly without restriction or loss of material.
1	Mechanical Sieve Shaker (with timer)—PTM No. 616
1 Set Each	Standard Sieves for Fine and Coarse Aggregate—ASTM E 11
1	Oven capable of maintaining a uniform temperature of 230F ± 9F—PTM No. 616
1	Calculating machine
1	Cylindrical Metal Measure 1 cubic foot— AASHTO T 19 and T 121, ASTM C136
1	Air Meter, acceptable type— AASHTO T 196 and T 152
1	Slump Cone— AASHTO T 119
1	Cylinder Compression Machine—PTM No. 604(1)
1	Curing Tank—PTM No. 611(2)
1	Capping Device—PTM No. 604(1)
1	Balance conforming to the requirements of AASHTO M 231 for the class of general purpose scale required, for the principle sample weight of the sample being tested—PTM No. 616.
1	Platform scale conforming to the requirements of AASHTO M 231 for the class of general purpose scale required, for the principle sample weight of the sample being tested—PTM No. 616, and AASHTO T 121 and ASTM C136
Sufficient	6-inch by 12-inch Cylinder Molds—PTM No. 611
	Necessary Incidental Equipment
1	Maturity Meter—PTM No. 640, if used
Sufficient	Temperature Sensors—PTM No. 640 if used

Note (1)—Equipment requirements may be waived if arrangements for testing have been made at the producer's central facility or at a commercial testing laboratory that participates in the AASHTO Accreditation Program in the area of Concrete Testing. Commercial testing laboratories are to conform to ASTM E329 for Concrete Inspection and Testing except for the equipment listed above.

Note (2)—Equipment requirements may be waived if, after 24 hours (±2 hours), specimens made for checking the strength of trial mixes are properly transported to a central facility or commercial testing laboratory for curing according to PTM No. 611.

Provide the plant with proper laboratory equipment, space, and utilities as specified in Section 609.

(b) Mixers and Agitators. AASHTO M 157. If directed, test air content of individual mixed concrete samples taken approximately at the beginning, the midpoint, and the end of the batch. If the air content varies by more than 1.5%, discontinue the use of the mixer or agitator until the condition is corrected.

If mixing in truck mixers at the plant, use inclined-axis, revolving-drum type mixers or horizontal-axis, revolving-drum high-discharge type mixers.

(c) Mixing and Delivery. Maintain concrete temperature after mixing between 50F and 90F for general concrete, and between 50F and 80F for bridge deck concrete. Do not ship concrete exceeding these temperature ranges. Maintain adequate two-way communications between the concrete plant and the work site to provide both uniformity and control of the concrete mixture.

For each truck, transmit a delivery ticket to the Representative at the time of each delivery (according to AASHTO M 157) with the following information:

- Contract number, complete state project number or purchase order number.

- The concrete plant supplier code.
- Method of concrete mixing (i.e., central or truck).
- Class of concrete, JMF number, and trial mix number (i.e., trial #1, 2, etc.).
- Number of cubic yards.
- Time of completion of mixing.
- Unique Truck ID.
- Number of mixing revolutions, if applicable.
- Total amount of batch water used in each truck (pounds).
- The total weight in pounds of the total cementitious materials.
- The types of additives used in each truck (i.e., water reducer, AEA, retarder, etc.).

Transmit the information on the batcher-mixer slip Form CS-4220 to the Representative. Do not use any concrete until it is approved for use by the Representative.

Conform to AASHTO M 157, except as follows:

- If mixing in a plant, mix for not less than 50 seconds or more than 90 seconds for normal strength concrete, and not less than 70 seconds for HES concrete.
- If mixing in the truck drum at the plant, mix for not less than 70 or more than 125 truck-drum revolutions, at a mixing speed of not less than 6 truck-drum revolutions per minute (rpm) nor more than 18 truck-drum rpm. Upon completion of the designated number of mixing revolutions, reduce the truck-drum speed to not less than 2 rpm or more than 6 rpm. Do not exceed a total of 300 truck-drum revolutions.

Deliver the mixed concrete to the work site and discharge within 11/2 hours after completion of mixing. As an alternative, use a set retarding admixture or a workability retention admixture or both, listed in Bulletin 15 and according to manufacturer's dosage recommendations, to extend the initial set time and time for discharge to 2 hours after the completion of mixing. Agitate, but do not mix the concrete en-route to the work site.

- In hot weather, under conditions contributing to quick concrete stiffening, or if the concrete temperature is 80F or above, do not allow the time between completion of mixing and discharge to exceed 1 hour. As an alternative to maintaining the concrete temperature below 80F, use an approved, set retarding admixture to extend the initial set time and enable the mix to remain workable for the full 11/2 hours of allowable mixing time.
- If using mixer or agitator trucks, agitate concrete for at least 20 revolutions immediately before placement. Do not use concrete that has exceeded 45 minutes without agitation.
- If wash water is used to clean the truck drum, completely discharge this wash water before the introduction of the succeeding batch.
- Do not allow concrete to come in contact with aluminum unless the aluminum is coated with an acceptable coating (delivery of concrete in an aluminum truck bed is allowed).

(d) Clean Out Areas. Concrete clean out areas, either contractor designed, or detailed within the contract documents, are incidental.

704.3 VOLUMETRIC MIXED CEMENT CONCRETE

(a) General. Use a plant inspected and listed in Bulletin 42. Make trial mixtures with a calibrated mixing plant. Provide plant equipment, facilities, and a concrete technician(s) as specified in Section 704.1. Do not begin production until the mixing plant and all equipment and facilities necessary for performing the work have been inspected and accepted. Mixing plants may be truck mounted.

(b) Usage. Volumetric mixing plants may be used to produce concrete for endwalls, inlets, manholes, end anchors, sign posts, and similar miscellaneous structures requiring small quantities of concrete. If allowed by the District Executive in writing, volumetric mixing plants may also be used for pavement patching and structures. Approved plants may produce concrete for precast items.

(c) Equipment. Prominently attach a permanent metal plate(s) to the plant plainly marking the gross volume in terms of mixed concrete, the operating speed, the plant auger mixing angle, and the plant weight-calibrated cement constant in terms of a revolution counter or other output indicator, all as rated by the manufacturer.

1. Compartments. Provide separate compartments to carry the ingredients. Cover the aggregate bins and prevent contamination and intermixing of the fine and coarse aggregates during loading and transporting. Keep the cement bins free of moisture and contamination. Provide suitable means to carry water and additives and to incorporate the additives with the mixing water in the mix.

2. Feed System. Provide a feeder system mounted under the compartment bins to deliver the ingredients to the mixing unit. Equip each bin with an accurately controlled individual gate to form an orifice for volumetrically measuring the material drawn from the bin compartment. Do not charge aggregate bins more than 4 hours before mixing.

Set the cement bin feeding mechanism to discharge a given volumetric weight equivalent of cement at a continuous and uniform rate during the concrete mixing operation. Coordinate the coarse and fine aggregate feeding mechanisms with the cement feeding mechanisms to deliver the required proportions.

3. Mixing Unit. Provide an auger-type mixer incorporated in the plant's discharge chute, or another suitable mixing mechanism that produces concrete of uniform consistency and discharges the mix without segregation. Examine the mixing screw daily and clean as necessary to prevent the build-up of mortar or concrete.

4. Dials and Measuring Devices. Equip the plant with accurate revolution-counter indicators that allow the volumetric weight equivalent of cement, fine aggregate, and coarse aggregate discharged to be read during the concrete-mixing operation. Equip the counter with a ticket print-out to record this quantity.

Equip the plant with a water flow meter or gauge to indicate the discharge rate of water (by volume) entering the mix and a water meter to register the total amount of water discharged during the mixing operation. Also, equip the plant with suitable gauges for checking the rate of flow of all additive(s) entering the mix. Coordinate the water and additive flow meters with the cement and aggregate feeding mechanisms. Equip the flow meters with scales appropriate for the type and amount of material being measured. Mount a tachometer indicating the drive shaft speed on the plant.

Place gauges, dials, and other devices that indicate the accuracy of concrete proportioning and mixing in full view so the operator can accurately read or readjust them while concrete is being produced. Provide the operator convenient access to all controls.

(d) Calibration. Use a unit constructed to allow convenient calibration of the gate openings and meters. Conduct a calibration once a year in the presence of Department representatives. Make satisfactory arrangements with the Department at least 1 week in advance of calibration. During the yearly calibration, calibrate the cement meter according to the manufacturer's recommendation and check the aggregate gate settings against the calibration data for the plant. Maintain the calibration data in the plant and submit the data to the District.

After performing the yearly calibration and before starting work, provide a mix design for review and acceptance and run a yield test to verify the design. Adjustments to correct for yield may require recalibration or a design change.

Conduct a recalibration if there is a change in the source of fine or coarse aggregate or cement. Conduct additional calibrations if directed. Provide each plant with data on the accepted recalibration.

If hydraulic drive units are used, perform the following additional calibration procedure: At the beginning of the actual batching operation, check the cement meter against the count and time used for the cement during the calibration of the individual materials. If a discrepancy occurs, adjust the belt speed of the unit so the actual cement meter count does not vary from the calibrated meter count by more than two counts per 60 seconds.

(e) Mixing and Delivery. Proportion, measure, and batch cement and aggregates by a weight equivalent method. The measuring and batching mechanism is required to produce the specified proportions of each ingredient within the following tolerances:

- Cement, Weight 0 to +4%
- Fine Aggregate, Weight ±2%
- Coarse Aggregate, Weight ±2%
- Admixtures, Weight or Volume ±3%
- Water, Weight or Volume ±2%

The tolerances are based on a volume/weight relationship established during the calibration of the measuring devices.

During mixing, maintain the drive shaft speed, as indicated by the tachometer, within 50 rpm of the operating speed. Set the auger mixer angle in the range determined by the manufacturer. Do not exceed 1/2 hour between the continuous placing of succeeding batches.

1. Testing. Conduct slump and air content tests according to PTM No. 601. Conduct the unit weight test, the concrete uniformity test, and the output meter calibration test according to AASHTO T 121, ASTM C136, AASHTO M 157, and PTM No. 626. If there is any doubt in the uniformity of the concrete, perform further testing as directed.

2. Recording. Provide a batcher mixer slip with each load of ingredients. Include the following information on the batcher mixer slip:

- Aggregate and moisture information.
- Class of concrete and the corresponding dial setting, as determined in the design.
- Water discharge rate limitations.

Use a separate batcher mixer slip for each class of concrete. Deliver the batcher mixer slip to the Representative at the work site. Do not use the concrete until the Representative verifies the data noted on the slip complies with the specifications.

(f) Clean Out Areas. Concrete clean out areas, either contractor designed, or detailed within the contract documents, are incidental.

Petrographic
PTM 518

Commonwealth of Pennsylvania
Department of Transportation

PA Test Method No. 518
October 2013
9 Pages

LABORATORY TESTING SECTION

Method of Test for

HAND SPECIMEN PETROGRAPHIC E AMINATION

1. SCOPE

1.1 This procedure covers petrographic testing methods for coarse aggregate, rock lining, and fine aggregate.

2. APPARATUS

2.1 Balance- A balance conforming to the requirements of AASHTO M-231, Class G2.

2.2 Sieves- Sieves conforming to the requirements of AASHTO M-92.

2.3 Common Rock Hardness materials:

2.3.1 Penny or Copper rod

2.3.2 Steel knife or nail

2.3.3 Glass Plate

2.3.4 Scratch plates (white and black) for determining the color of powdered material

2.3.5 Munsel Rock Color Chart or Munsel Soil Color Chart

2.3.6 Ruler, marked to 1/16th or 1/32nd of an inch. Also marked to 1 mm.

2.3.7 Dilute Hydrochloric Acid (1:4 concentration)

2.3.8 Magnet

2.3.9 Tweezers

2.3.10 Illuminated Magnifier

2.3.11 Hand lens

2.3.12 Binocular Microscope (0.7   to 3   , with 10   objectives)

2.3.13 Hammer, anvil, and pans

3. HAND SPECIMEN PETROGRAPHIC PROCEDURE

3.1 Coarse Aggregate (6.5 mm 0.25 in)(Section 703.2 of Publication 408):

3.1.1 Sieve 800 to 2000 grams of washed and oven-dried aggregate. Remove material that is finer than the 6.5 mm (1/4 inch) screen.

3.1.2 Visually examine the aggregate retained on the 6.5 mm (1/4 inch) sieve.

3.1.3 Record the lithology, fresh and weathered colors, grain or crystal size, degree of weathering or alteration, mineralogy, nature of cement or matrix, presence of deleterious minerals, materials, or coatings, fossils, bioturbation, carbonaceous material, and presence of laminae, bedding, foliation, or fractures.

3.1.4 Determine the hardness of the individual clasts using a copper rod, glass plate, and knife blade.

3.1.5 Separate out the different lithologies.

3.1.6 Use dilute HCl to determine the presence of carbonate cements and types of carbonate (dolomite, calcite) and the presence of carbonaceous or argillaceous material.

3.1.7 Use the binocular microscope, magnifier, or hand lens to determine the mineralogy of small grains or crystals, degree of bedding, banding, and interlocking structure and degree of cementation or weathering on individual grains or between grains.

3.1.8 Classify *Carbonate Rocks* using ASTM C 294, Section 20 and Reference 5.6 in this PTM.

3.1.9 Classify *Conglomerates, Sandstones, and Quartzites* using ASTM C 294 Section 18, and Krynine s classification (Chart 1 in this PTM).

3.1.10 Classify *Claystone, Shales, Argillites, and Siltstones* using ASTM C 294 Section 19, and Table 1.

3.1.11 Classify *Igneous and Metamorphic Rocks* using ASTM C 294 Sections 15 and 23.

3.1.12 Classify *Blast Furnace and Steel Slags, Fly and Bottom Ash*, *and Recycled Concrete* based on training, experience, and using Chart 2 in this PTM.

3.1.13 Separate the potentially deleterious material (ferrous particles (use a magnet), coal, shale, shaley siltstone, shaley limestone, wood fragments, etc.).

3.1.14 If the potentially deleterious material exceeds the specifications for the aggregate in the current issue of PENNDOT Publication 408, submit the material for additional tests (wet/dry test using PTM 519, x-ray diffraction, etc.).

3.1.15 Determine the relative percentages of the lithologies by mass weighing the material to an accuracy of 0.1 gram:

3..1.15.1 Mass of Lithology/Total Mass of Sample = Relative Percentage of Lithology

3.2 Rock Lining (Section 850 in PENNDOT Publication 408):

3.2.1 Wash and oven-dry the Rock Lining sample.

3.2.2 Measure the length, width, and thickness of the individual clasts. Note whether the ratio of length to either width or thickness exceeds 3:1 (Section 850.2(a) in PENNDOT Publication 408).

3.2.3 Visually examine the Rock Lining. Note the lithology, fresh and weathering colors, grain or crystal size, degree of weathering or alteration, presence of deleterious minerals, materials, or coatings, presence of laminae, bedding, fractures, and/or grain shape.

3.2.4 Determine the hardness of individual clasts using a copper rod, glass plate, and knife blade.

3.2.5 Separate out the different lithologies.

3.2.6 Use dilute HCl to determine the presence of carbonate cements and types of carbonate (exp. dolomite, calcite).

3.2.7 Classify *Carbonate Rocks* using ASTM C 294, Section 20 and Reference 5.6. in this PTM.

3.2.8 Classify *Conglomerates, Sandstones, and Quartzites* using ASTM C 294, Section 18, and Krynine s classification (Chart 1 in this PTM).

3.2.9 Classify *Claystone, Shales, Argillites, and Siltstones* using ASTM C 294, Section 19, and Table 1.

3.2.10 Classify *Igneous and Metamorphic Rocks* using ASTM C 294, Sections 15 and 23.

3.2.11 Classify *Blast Furnace and Steel Slags, Fly and Bottom Ash***,** *and Recycled Concrete* based on training and experience and using Chart 2 in this PTM.

3.2.12 Separate the potentially deleterious material (ferrous particles (use a magnet), coal, shale, shaley siltstone, shaley limestone, woody fragments, etc.).

3.2.13 If the potentially deleterious material exceeds the specifications for the aggregate in the current version of PENNDOT Publication 408 submit the material for additional testing.

3.2.14 Determine the relative percentages of the lithologies by mass weighing the material to an accuracy of 1.0 gram:

3.2.14.1 Mass of Lithology/Total Mass of Sample = Relative Percentage of Lithology.

3.3 Fine Aggregate (6.5 mm 0.25 in.) (Section 703.1 in Publication 408):

3.3.1 Sieve 250 to 500 grams of washed aggregate examine material that passes the 6.5mm (1/4 inch) screen.

3.3.2 Count a minimum of 160 grains (where possible) from each of the Nos. 4, 8, and 16 screens (add the material retained on the #20 screen if insufficient material is present on the larger screens):

3.3.3 Visually examine the aggregate. Note the lithology, fresh and weathering colors, grain or crystal size, composition of cement or matrix, degree of weathering or alteration, presence of deleterious minerals, materials, or coatings, and presence of laminae, bedding, or fractures.

3.3.4 Determine the hardness of the individual clasts using a copper rod, glass plate, and knife blade.

3.3.5 Separate out the different lithologies.

3.3.6 Use a magnet to separate out ferrous particles.

3.3.7 Use dilute HCl to determine the presence of carbonate cements and types of carbonate (exp. dolomite, calcite).

3.3.8 Use the binocular microscope or a hand lense to determine the mineralogy of the small grains or crystals, degree of bedding or interlocking structure, and the degree of weathering on individual grains or between grains.

3.3.9 Classify *Carbonate Rocks* using ASTM C 294, Section 20 and Reference 5.6 in this PTM).

3.3.10 Classify *Conglomerates, Sandstones, and Quartzites* using ASTM C 294 Section 18, and Krynine s classification (Chart 1 in this PTM).

3.3.11 Classify *Claystone, Shales, Argillites, and Siltstones* using ASTM C 294 Section 19, and Table 1.

3.3.12 Classify *Igneous and Metamorphic Rocks* using ASTM C 294, Sections 15 and 23.

3.3.13 Classify *Blast Furnace and Steel Slags, Fly and Bottom Ash***,** *and Recycled Concrete* based on training and experience and using Chart 2 in this PTM.

3.3.14 Separate the potentially deleterious material (coal, shale, shaley siltstone, shaley limestone, ferrous material etc.).

3.3.15 Weigh the deleterious particles and compare their weights to the weight of material retained on the 6.5 mm (1/4 inch) sieve.

3.3.16 Determine the relative percentages of the lithologies using point counts:

3.3.16.1 Point Count of Individual Lithology/Total Point Count of Sample = Relative Percentage of Lithology.

4. RE UIRED RECORDS

4.1 TR- 447 Sample Identification

4.2 TR- 4127 Petrographic Description Lab Report

4.3 Petrographic Data Tables/Spread Sheet

5. REFERENCE DOCUMENTS

5.1 ASTM C 294, Standard Descriptive Nomenclature for Constituents of Natural Mineral Aggregates

5.2 ASTM C 1005, Standard Specification for Reference Masses and Devices for Determining Mass and Volume for use in the Physical Testing of Hydraulic Cements

5.3 AASHTO M-92, Specification for Wire-Cloth Sieves for Testing Purposes

5.4 PENNDOT Specifications: Publication 408

5.5 PENNDOT PTM 519, Method of Test for Wet/Dry Durability Test

5.6 Folk, R.L., 1968. Petrology of Sedimentary Rocks: The University of Texas, Hemphill s, Austin, T (pp. 152-168).

6. TRAINING

6.1 The Petrographer shall have a Bachelor s Degree in Geology, or its equivalent.

7. ATTACHMENTS

3.1 Chart 1- Rock Classification Chart Used by the Petrographic Unit

3.2 Chart 2 - Slag Classification Chart Used by the Petrographic Unit

CHART 1: ROCK CLASSIFICATION USED BY THE PETROGRAPHIC UNIT

Igneous and Metamorphic Rocks: Classification based on ASTM C 294, Sections 15 and 23
Sedimentary Rocks:

Carbonate Rocks: classification based on ASTM C 294, Section 20 with additional descriptions from Folk, R.L., 1968. Petrology of Sedimentary Rocks: The University of Texas, Hemphill s, Austin, T (pp. 152-168).

Conglomerates, Sandstones, and uartzites: classification based on ASTM C 294, Section 18 with further elaboration from Krynine s classification (below).

Conglomerate- quartz, graywacke, or arkosic with descriptive adjective relating to the size of particles (pebble, granule, etc.). Conglomerate includes any rock with particles over 2 mm (0.08 in.) in diameter.

Sandstone and Quartzite- grains ranging in diameter from 0.0625 mm (0.003 in.) to 2 mm (0.08 in.).

Quartzite- uartz grains plus over 75% silica in the cement
Impure Quartzite-   uartz grains plus 51% to 75% silica in the cement
Quartzitic Sandstone-   uartz grains plus 25% to 50% silica in the cement
Quartzose Sandstone-   uartz grains plus less than 25% silica in the cement
Graywacke- Gray, greenish gray, to reddish gray sandstone, containing quartz, feldspar, and rock fragments in a matrix resembling claystone or shale

Claystone, Shales, Argillite, Siltstone- based on ASTM C 294, Section 19 with the following additions:

Shale and Siltstone Classification

TEST	LAMINATED (FISSILE)	NON-LAMINATED
Fingernail scratches rock	*Clay Shale*	*Claystone*
Penny barely scratches rock	*Shale* with thin laminae (less than 5 mm 0.2 in.), possibly silty or calcareous	*Argillite*
Rock scratches glass with effort	*Shaley Siltstone* with thick laminae (5 mm 0.2 in)	*Silty Argillite*
Rock scratches glass easily	*Laminated Siltstone*	*Siltstone*

CHART 2: SLAG CLASSIFICATION USED BY THE PETROGRAPHIC UNIT

BLAST FURNACE	OPEN HEARTH
Finely to Coarsely Crystalline	Finely Crystalline to Microcrystalline
Low Density	High Density
Highly Vesicular	Few Vesicles
Rotten Egg Smell	
Colors: olives, browns, blues, greens	Darker Colors: dark grays, brownish black

LOOK FOR:

- Fire Brick
- Flux (LS, SS, SH)
- Coal, Coke, glassy particles
- Friable Particles and Aggregates
- Iron Particles (highly magnetic) Removed from the matrix.
- Slightly Magnetic Aggregates
- Lime Particles (resembles *caliche*) and Lime Crystals

Use Section 703.2.a Table B in the PENNDOT Publication 408:

	Type A	Type B	Type C
Friable Particles	**1 %***	**1%**	**------**
Coal or Coke	**1%**	**1%**	**5%**
Iron	**3%**	**3%**	**3%**
Glassy Particles	**4%** or 0%*****	**4%** or 0%*****	**------**

Percent by Weight
for cement or concrete
for bituminous

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Wet Dry
PTM 519

LABORATORY TESTING SECTION

Method of Test for

WET-DRY DURABILITY TEST

1. SCOPE

1.1 This test is used to determine the resistance of shaley material to splitting and cracking under conditions of successive and alternating exposure to wetting and then drying. The test is generally performed on processed coarse aggregate samples (except for AASHTO #10 s) which have been found to contain, through petrographic analysis of a hand sample specimen, total amounts of shaley material exceeding the allowed specification limits for deleterious shale as stated in Table B, Section 703.2 of Publication 408. This test can also be performed on unprocessed coarse aggregate samples, such as material intended for use in embankments and backfill, in order to give the potential user an indication of how the material may perform through time. This test is also applicable to coarse aggregate extracted from a bituminous overlay, in order to evaluate the current durability and quality of the aggregate present in the overlay, and to help evaluate whether or not the overlay will perform as expected during the remainder of its anticipated life span.

1.2 This test is not applicable to processed fine aggregates and AASHTO # 10 s.

1.3 For the purposes of this test only, the term shaley material includes the following categories of rock types:

1.3.1 shale - a very fine-grained detrital sedimentary rock composed of silt-sized and clay-sized particles, that are thinly bedded and which tend to part along the bedding planes.

1.3.2 shaley limestone - limestone, which is composed mainly of $CaCO_3$, that is thinly bedded and has thin beds of shale intercalated between the thin layers of limestone, and which tends to part along the bedding planes.

1.3.3 shaley laminated siltstone- a fine-grained to very fine-grained detrital sedimentary rock, thinly bedded, which consists of intercalated beds of predominantly silt-sized material and shale, and which tends to part along the bedding planes.

> Note 1- It is assumed that the person who performs the petrographic analysis or identifies the presence of shaley material in the sample is qualified by education and experience to describe and classify the individual constituents of an aggregate sample.

1.4 This test is not applicable to fine-grained detrital sedimentary rocks that are massive and show absolutely no signs of bedding on a fine scale, such as massive argillites, mudstones, and claystones.

2. REFERENCED DOCUMENTS

2.1 AASHTO Standards:

2.1.1 M 231, Weighing Devices Used in the Testing of Materials

2.1.2 R 76, Reducing Samples of Aggregate to Testing Size

2.1.3 R 90, Sampling Aggregate Products

2.2 ASTM Standard:

2.2.1 E11, Standard Specification for Woven Wire Test Sieve Cloth and Test Sieves

2.3 PennDOT Publication:

2.3.1 Publication 408, Specifications

3. APPARATUS

3.1 Pans - Pans shall be composed of metal or a plastic, durable at the required oven temperature (see Section 3.3), and shall be deep enough to allow the sample to be completely covered by at least 6.4 mm (1/4 inch) of water.

3.2 Syringe or aspirator - A syringe consisting of a rubber squeeze bulb and nozzle with a capacity of at least 80 cc has been found to be satisfactory.

Note 2- A satisfactory style of syringe may be found in automotive supply stores which supply batteries and battery accessories. Such stores usually stock a syringe or bulb aspirator for adjusting the level of acid in unsealed batteries that can be used in this test without any alterations.

3.3 Ovens

3.3.1 Oven - An oven which shall be capable of maintaining a temperature of 60 °C 3 °C (140F 5F), and shall be large enough to hold as many samples as are likely to be tested at the same time.

3.3.2 Oven - An oven which shall be capable of maintaining a temperature of 110 °C 5 °C (230F 9F), and shall be large enough to hold as many samples as are likely to be washed at the same time.

3.4 Sieves - A 4.75 mm (#4), 6.3 mm (1/4 inch), 25.0 mm (1 inch), and 50.0 mm (2 inches) sieves, conforming to ASTM E11.

3.5 Balance - The balance shall conform to Class G2 of AASHTO M 231 for samples less than 2000 g (4.4 pounds) or Class G5, AASHTO M 231, for samples 2000 g (4.4 pounds) or more, but less than 5000 g (11 pounds).

3.6 Brush - A brush of sufficient size and with sufficiently heavy bristles to loosen dried, fine particles from the bottom of the pan at the end of the test.

4. SAMPLE

4.1 Processed coarse aggregate samples

4.1.1 Processed coarse aggregate samples on which this test may be performed shall be obtained in accordance with AASHTO R 90. Any processed coarse aggregate samples coarser in gradation than an AASHTO #467 shall be treated as an unprocessed coarse aggregate sample (Section 4.2).

4.1.2 The sample shall be reduced in size by AASHTO R 76 to a weight slightly higher than the minimum desired weight (Section 4.1.5).

4.1.3 Wash the reduced sample in order to remove all fines and adhering dust, and dry in an oven capable of maintaining 110 °C 5 °C (230F_9F). This is the standard temperature range used in preparing aggregate samples for various tests.

4.1.4 Grade the sample from Section 4.1.3 over a 6.3 mm (1/4 inch) sieve and discard the material that passes this sieve.

Note 3- Sections 4.1.3 and 4.1.4 may be performed in reverse order, if desired.

4.1.5 The final test sample of processed coarse aggregate shall meet the minimum weight requirement given below:

Original Gradation	Minimum Weight
AASHTO #8 and #7	800 g
AASHTO #467, #5, #57, #67	1000 g
PA 2A or OGS	1200 g

Record the weight (W_o) of the final test sample to the nearest tenth of a gram (ounce).

4.1.6 After obtaining the final test sample, it may be prepared for the wet-dry test in one of two ways:

4.1.6.1 If the final test sample contains a fraction identified as shaley material (Note 1), check each piece of shaley material for cracks. Set any cracked pieces of shaley material aside, after noting their total weight (C_s) to the nearest tenth of a gram. The bulk of the sample is now ready for the wet-dry test.

4.1.6.2 Instead of performing the wet-dry test on the entire final test sample of processed coarse aggregate the following procedure may be followed:

4.1.6.2.1 Perform a petrographic analysis on the final test sample (Note 1), and record the weights of each of the rock types present in the sample to the nearest tenth of a gram.

4.1.6.2.2 Calculate the percentage, by total sample weight, of the portion of the final test sample comprised of shaley material. For example:

Weight of the final test sample (W_o)	1010.0 g
Weight of shaley material in the test sample (S_o)	100.0 g

% shaley material in the test sample

$$\frac{S_o}{W_o} x100 = \frac{100g}{1010g} x100 = 9.9\%$$

4.1.6.2.3 The wet-dry test will be performed if the percentage of shaley material present in the final test sample exceeds the allowed limit of deleterious shale for the designated quality level of the aggregate (see Table B, Section 703.2, Publication 408, Deleterious Shale, Max. %, for Types A, B, and C coarse aggregates). Otherwise, discard the entire test sample, and do not proceed with the remainder of the test procedure.

4.1.6.2.4 Prepare the shaley material for the wet-dry test by checking each piece of shaley material for cracks. Set aside the cracked pieces after noting their total weight (C_s) to the nearest tenth of a gram. The shaley material fraction of the final test sample is now ready for the wet-dry test.

4.2 Unprocessed coarse aggregate samples (and processed coarse aggregate samples coarser than AASHTO #467 s)

4.2.1 Samples shall be obtained in the field in accordance with AASHTO R 90.

4.2.2 Pieces of the sample larger than 50.8 mm (2 inches) (maximum dimension) shall be broken down to less than 50.8 mm (2 inches). The whole sample shall be passed over a 50.0 mm (2 inches) and a 25.0 mm (1 inch) sieve. Only the material passing the

50.0 mm (2 inches) and retained on the 25.0 mm (1 inch) sieve shall be utilized in the wet-dry test. If necessary, reduce the amount of sized material by AASHTO R 76 to obtain a workable test sample, and set the remainder of the minus 50.0 mm (2 inches) plus 25.0 mm (1 inch) material to one side.

4.2.3 Wash the test sample to remove fines and adhering dust, and dry in an oven capable of maintaining 110 °C_5 °C (230F _9F). If during the process of washing the sample of unprocessed rock, pieces of the sample begin to disintegrate, immediately stop the washing process, discard the sample, and split out a new sample from the remaining minus 50.0 mm (2 inches) plus 25.0 mm (1 inch) material from Section 4.2.2. For the new sample, immediately go from Section 4.2.2 to Section 4.2.4, and do not attempt to wash the new sample.

4.2.4 The sample from Section 4.2.3 or Section 4.2.2 (if unwashed) shall not weigh less than 800 g (1.75 pounds).

4.2.5 After obtaining the final test sample, prepare it for the wet-dry test as follows (Note 1):

4.2.5.1 If the final test sample contains a fraction identified as shaley material, check each piece of shaley material for cracks. If it does not contain shaley material, do not proceed with this test.

4.2.5.2 Discard any cracked pieces of shaley material, and check the weight of the remaining sample, which shall not be less than 800 g (1.75 pounds).

4.2.5.3 If the sample now weighs less than 800 g (1.75 pounds), combine this material with the remaining minus 50.0 mm (2 inches) plus 25.0 mm (1 inch) fraction from Section 4.2.2, and resplit the sample to produce a test sample of sufficient size that will weigh at least 800 g (1.75 pounds) when any cracked pieces of shaley material are removed.

4.2.5.4 Note the weight of the final test sample (W_o) to the nearest tenth of a gram.

4.2.5.5 The sample is now ready for the wet-dry test, if you wish to perform the test on the bulk sample.

4.2.6 If you wish to subject only the shaley material portion of the prepared, unprocessed rock sample to the wet-dry test, remove the shaley material from the prepared sample (Note 1), and record the weight of the shaley material fraction (S_o) from the prepared sample to the nearest tenth of a gram.

4.3 Coarse aggregate samples extracted from bituminous overlays

4.3.1 Take the extracted aggregate sample, which usually includes the coarse and the fine aggregate fractions, and sieve it over a 6.3 mm (1/4 inch) sieve, saving the material finer than the 6.3 mm (1/4 inch) sieve. Weigh the plus 6.3 mm (1/4 inch) aggregate. If this material weighs more than 400 g (14 ounces), proceed to Section 4.3.2. If the plus 6.3 mm (1/4 inch) material weighs less than 400 g (14 ounces), recombine it with the minus 6.3 mm (1/4 inch) material, and resieve the entire sample over the 4.75 mm (#4) sieve. If the sample of plus 4.75 mm (#4) material weighs 400 g (14 ounces) or more, proceed with the test. If the plus 4.75 mm (#4) material weighs less than 400 g (14 ounces), do not proceed with the remainder of the test.

4.3.2 Wash the aggregate sample in acetone to remove as much of the remaining asphalt binder as possible, and dry the sample to a constant weight in an oven capable of maintaining 60 °C 3 °C (140F 5F).

4.3.3 Resieve the aggregate sample over the 4.75 mm (#4) sieve to remove any fines released from the coarse aggregate particles by the acetone bath. Reweigh the plus 4.75 mm (#4) aggregate. If the plus 4.75 mm (#4) aggregate sample weighs less than 400 g (14 ounces), do not proceed with the remainder of the test. If the plus 4.75 mm (#4) aggregate sample weighs 400 g (14 ounces) or more, record the sample weight (W_o) to the nearest tenth of a gram, and proceed with the test.

4.3.4 Perform a petrographic analysis of the sample. Note the different types of rocks present, record the weight of each individual rock type present to the nearest tenth of a gram (S_o, for the shaley material fraction), and calculate the percentages, by total sample weight (W_o), of each type of rock present in the sample (Note 1). Since the color of the rock types present will have been distorted somewhat by the use of an asphalt binder, only the general color ranges of the rock types present should be noted.

4.3.5 The wet-dry test shall be performed on the shaley material from the extracted aggregate sample if the total percentage of shaley material present in the extracted coarse aggregate sample exceeds the allowed limit of deleterious shale for the designated quality level of the coarse aggregate (see Table B, Section 703.2, Publication 408, Deleterious Shale, Max. %, for Types A, B, and C coarse aggregates). Otherwise, there is no point in continuing with the remainder of the test procedure.

4.3.6 Prepare the shaley material for the wet-dry test by checking each piece of these materials for cracks. Set aside any cracked pieces, after noting their total weight (C_s) to the nearest tenth of a gram. The shaley material fraction of the extracted aggregate sample is now ready for the wet-dry test.

5. PROCEDURE

5.1 Place the test sample in a pan and cover the sample with at least 6.4 mm (1/4 inch) of water. If necessary, split a sample between two or more pans in order to achieve the necessary amount of water coverage. Soak the sample for 17 hours _ 2 hours. After this period is over, remove the water by first pouring the water off, and then by suction using the syringe or aspirator. While removing the water from the pans, be very careful not to lose any material, large or small, from the pan(s).

5.2 After removing the water from the sample(s), place the sample(s) in an oven at 60 °C _ 3 °C (140F _ 5F) and dry the sample(s) for 7 hours _ 1 hour.

5.3 Repeat the cycle of wetting and drying three (3) more times. After removing the samples from the oven, allow them to cool to room temperature before they are covered with water again.

5.4 After the end of the fourth cycle, remove the sample(s) from the oven, and allow the pan(s) to cool to room temperature.

5.5 Remove any pieces of shaley material from the sample that show the following characteristics:

5.5.1 Splitting or cracking apart, which is apparent through simple visual inspection, or which occurs through application of moderate manual pressure to the piece of aggregate.

NOTE 4- Sometimes an aggregate particle may split apart during the test, and the resulting smaller pieces will become separated from each other. Such pieces of aggregate are considered to be part of the deleterious fraction, and can be detected by looking for pieces of aggregate with freshly exposed surfaces that can be matched so that the smaller pieces fit together to form one larger piece of aggregate.

5.5.2 Complete or partial disintegration to minus 4.75 mm (#4) sieve-sized material.

NOTE 5- Pieces of shaley material which undergo partial disintegration typically lose their sharper edges in the process, and end up with rounded areas that have fresher, darker colors, that are interspersed with more weathered areas that represent the centers of the original fractured faces. The disintegrated material frequently ends up as minus 4.75 mm (#4) sieve-sized material, and may have to be brushed out of the pan into the container of deleterious shale with a stiff-bristled brush.

Where a piece of shaley material has completely disintegrated during the test, the disintegrated material will have to be brushed out of the pan into the container of deleterious shale with a stiff-bristled brush.

The shaley material that shows these characteristics is considered as being the deleterious shale fraction. Weigh the shale, and record the weight (D_s) to the nearest tenth of a gram. Weigh the remaining non-deleterious fraction, and record its weight to the nearest tenth of a gram.

NOTE 6- Depending on how the sample was processed, this non-deleterious fraction may consist only of non-deleterious shaley material (N_s), or it may consist of non-deleterious shaley material and other rock types (N_{sr}) (Section 4).

6. CALCULATIONS

6.1 Check for excessive loss of material during the pour-off of water

6.1.1 Bulk processed aggregate samples (Section 4.1.6.1)

W_o = weight of the final test sample
C_s = weight of cracked pieces of shaley material removed before the start of the test
D_s = weight of deleterious shale after the end of the test
N_{sr} = weight of non-deleterious shaley material and other rock types after the end of the test

Add together the following weights: C_s, D_s, and N_{sr}. These three weights, when added together, normally do not differ from W_o, the final test sample weight, by more than 2 g. If the total of these three weights is more than 3 g less than W_o, then material has been lost during the pour-off of water at the end of the soaking periods. The sample shall be discarded and the test repeated using a fresh sample.

6.1.2 Bulk unprocessed aggregate samples (Section 4.2)

W_o = weight of the final test sample
D_s = weight of deleterious shale after the end of the test
N_{sr} = weight of non-deleterious shaley material and other rock types after the end of the test

Add together the following weights: D_s and N_{sr}. These two weights, when added together, normally do not differ from W_o, the final test sample weight, by more than 2 g. If the total of these two weights is more than 3 g less than W_o, then material has been lost during the pour-off of water at the end of the soaking periods. The sample shall be discarded, and the test repeated using a fresh sample.

If the sample was not washed, the total of D_s and N_{sr} shall be no more than 4 g less than W_o. Otherwise, the test shall be repeated using a fresh sample.

6.1.3 Shaley material fraction from processed aggregate samples (Section 4.2), and shaley material fraction from asphalt-extracted aggregate samples (Section 4.3).

S_o = weight of the shaley material fraction of the sample
C_s = weight of the cracked pieces of shaley material removed before the start of the test
D_s = weight of deleterious shale after the end of the test
N_s =weight of non-deleterious shaley material after the end of the test

Add together the following weights: C_s, D_s, and N_s. These three weights, when added together, normally do not differ from S_o, the original weight of the shaley material fraction, by more than 1 g. If the total of these three weights is more than 2 g less than S_o, then material has been lost during the pour-off of water at the end of the soaking periods. The sample shall be discarded, and the test repeated using a fresh sample.

6.1.4 Shaley material fraction from unprocessed aggregate samples (Section 4.2).

S_o = weight of the shaley material fraction of the sample
D_s = weight of deleterious shale after the end of the test
N_s = weight of non-deleterious shaley material after the end of the test

Add together the following weights: D_s and N_s. These two weights, when added together, normally do not differ from S_o, the original weight of the shaley material fraction, by more than 1 g. If the total of these two weights is more than 2 g less than S_o, then material has been lost during the pour-off of water at the end of the soaking periods. The sample shall be discarded, and the test repeated using a fresh sample.

If the sample was not washed, the total of D_s and N_s shall be no more than 4 g less than S_o. Otherwise, the test shall be repeated using a fresh sample.

6.2 Percent deleterious shale calculation

W_o = original total weight of the entire sample
D_s = weight of deleterious shale found in the sample after the test
P_{ds} = percent deleterious shale in the sample

Calculate the percent of deleterious shale in the sample, using the following formula:

$$P_{ds} = \frac{D_s}{W_o} x 100$$

7. REPORT

7.1 Report the percent of deleterious shale found in the sample to the nearest tenth of a percent. Specify the type of sample on which the test was performed (Section 4), and state how the sample was prepared for the test. If a specification limit for deleterious shale applies to the sample, state whether the sample meets or fails to meet the applicable specification limit. Finally, state in a clear and concise manner the qualifications of the person who performed the petrographic analysis or identified the presence of shaley material in the sample.

Bulletin 14

VII. Bulletin 14 (PennDOT Publication 34) Approved Aggregate Producers:

Bulletin 14 can be accessed on the web at: www.penndot.gov ; Forms and Publications; Bulletin 14 (Publication 34) Aggregate Producers.

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF TRANSPORTATION

Bureau of Project Delivery
Materials and Testing Division
81 Lab Lane
Harrisburg, PA 17110-2543

BULLETIN 14

Publication 34

AGGREGATE PRODUCERS

1. DESCRIPTION

A. General.

The aggregate producers listed in this Bulletin have demonstrated their capability to produce material meeting the Department's specification requirements for the type and source listed. Listing in this Bulletin does not provide assurance that the material from these sources will meet the requirements of the specifications at all times.

B. Meaning of Terms

For the purpose of this Bulletin, the term "producer" is any individual, firm, partnership, corporation, joint venture or other entity manufacturing aggregate with the intent of meeting the Department Publication 408, Section 703 requirements. A source is a single, specific quarry, pit, or bank location. An agent is any individual, firm, partnership, corporation, joint venture or other entity distributing aggregates with the intent of meeting the Department Publication 408, Section 703 requirements.

The language in this Bulletin is generally written in the imperative mood. In sentences using the imperative mood, the subject, "the Producer" is implied. Also implied in this language are "shall", "shall be", or similar words and phrases. The word "will" generally pertains to decisions or actions of the Department and/or the Engineer. The following words, or similar words, refer to actions of the Department and/or the Engineer, unless otherwise stated: "directed", "required", "permitted", "ordered", "designated", "prescribed". Also, the words "approved", "acceptable", "satisfactory", "considered", or words with similar intent, mean by, or to, the Department and/or the Engineer, subject in each case to the final determination of the Secretary, and subject to further review, as permitted by law or permitted elsewhere in this Bulletin or the Department's specifications, Publication 408.

2. PRELIMINARY APPROVAL PROCEDURE

Aggregate Producers:

Prospective aggregate producers offering a source for approval shall request an investigation from the appropriate District Materials Engineer/Manager (DME/DMM) responsible for the source location. All available information relative to the exploratory work conducted in developing the source shall be made accessible for review by the DME/DMM. Test results shall be provided from an independent testing agency indicating the quality of the aggregate being offered meets Department requirements as set forth in Section 703 of Pub. 408. The DME/DMM will review this information and, if satisfactory, will proceed with the investigation. The Bureau of Project Delivery, Construction and Materials Division (CMD), Laboratory Testing Section (LTS) has the responsibility to approve the listing and assign the codes for the aggregate producers in this Bulletin following the investigation and recommendation for approval by the DME/DMM. It is not the policy of the Department to provide exploratory testing to qualify sources offered by prospective suppliers. The LTS, however, will provide a preliminary Skid Resistance Level rating for coarse aggregate samples completely identified as to source and location. The producer is solely responsible for determining if any federal or state approval or permit is required for the material and for applying for and obtaining all required federal and state approvals and permits. Any material sold to the Department must be in full compliance with all federal and state laws and regulations and must have state approvals and permits that allow the material to be sold and used for the Department's required use. This includes verification, where applicable, that a specific material is a "co-product" in relation to the Department of Environmental Protection residual waste regulations. Producers of non-natural occurring aggregate material particularly must be sure they are complying with regulations issued by the PA Department of Environmental Protection regarding slag, cinders, bottom ash, etc. This applies to all aggregate sources listed in this Bulletin, regardless of when they were originally approved.

Agents:

Prospective aggregate agents offering an aggregate distributing source location for approval shall request an investigation from the appropriate District Materials Engineer/Manager (DME/DMM) responsible for the aggregate distributing source location.

A. Facility Requirements
At each source, provide a building of sufficient size with all of the following equipment at the quarry site. The facility and equipment must be in place prior to receiving the recommendation for approval from the DME/DMM and must be maintained to continue the source listing in the Bulletin:

(1) Equipment

a. Fine Aggregate

No.	Equipment
1	F.A. Mechanical Sieve Shaker with Timer
1	Sample splitter having an even number of equal width chutes that discharge alternately to each side of the splitter. A minimum of twelve total chutes is required. The minimum width of the individual chutes is to be at least 50 percent larger than the largest particles in the sample and the maximum width of the individual chutes is to be 20 mm (3/4-inch). Include two receptacles to hold the samples following splitting. Splitter design must allow samples to flow smoothly without restriction or loss of material.
2	Set of Standard Sieves for F.A., meeting ASTM E11 standards
1	Balance conforming to the requirements of AASHTO M 231 for the class of general purpose scale required for the principal sample mass (weight) of the sample being tested, PTM No. 616.
1	Oven capable of maintaining a uniform temperature of 110 ºC ± 5 ºC (230F ± 9F)
1	Thermometer, ASTM

E1**. b. Coarse Aggregate**

No.	Equipment
1	C. A. Mechanical Sieve Shaker with Timer
1	Sample splitter having an even number of equal chutes that discharge alternately to each side of the splitter. A minimum of eight total chutes is required. The minimum width of the individual chutes is to be at least 50 percent larger than the largest particles in the sample. Include two receptacles to hold the samples following splitting. Splitter design must allow samples to flow smoothly without restriction or loss of material.
2	Set of Standard Sieves for C. A., meeting ASTM E11 standards
1	Cylindrical Metal Measure [25 L (1 cu. Ft.)] AASHTO T 19
1	Balance conforming to the requirements of AASHTO M 231 for the class of general purpose scale required for the principle sample mass (weight) of the sample being tested, AASHTO T 85
1	Platform scale conforming to the requirements of AASHTO M 231 for the class of general purpose scale required for the principle sample mass (weight) of the sample being tested, PTM No. 616.

1	Oven capable of maintaining a uniform temperature of 110 °C ± 5 °C (230F ± 9F).
1	Thermometer, ASTM E1.

Provide a separate set of sieves for exclusive use by the Department. The remaining equipment is to be shared by the producer and the Department. If time or space conflicts arise, or if the Department does not have consistent access to shared equipment when testing is to be performed, provide a separate set of equipment for the Department.

During production, provide the necessary incidental equipment to conduct and document the tests. The equipment and test result documentation are a condition for source acceptance, source re-qualification, and continued listing in this Bulletin.

(2) Facility and Maintenance

Perform routine maintenance and repair all equipment whether shared or for exclusive Department use. Have balances calibrated annually by an independent agency acceptable to the Department. Verify oven temperatures every 120 days using the thermometer supplied as required equipment. Maintain accurate records of calibration and temperature checks. Have back-up equipment available so that no tests are missed.

Provide a source of clear, running water satisfactory to the DME/DMM.

Provide a complete library of all pertinent PTMs, Pub. 408 Specification Sections, ASTM and AASHTO standards, and Pub. 194 (Trucker Handbook).

Provide the following office equipment in the facility for exclusive Department use:

No.	Equipment
1	Desk and chair
1	Electronic calculator with tape and statistical function
1	Worktable 2 ½ feet x 7 feet x 2 ½ feet high
1	4 drawer, fire resistant (D-label) metal file cabinet (A two drawer fire resistant cabinet may be substituted with permission of the DME/DMM).
1	Closet or locker for storage

If testing equipment is to be shared, provide a minimum of 150 square feet of office and workspace. If a separate set of testing equipment is provided for the Department, provide a minimum of 240 square feet of office and workspace to accommodate both the office and the testing equipment. The office and workspace area provided must be heated/air-conditioned and have on-site access to a water cooler, telephone, fire extinguisher, and sanitary toilet facilities. Clean office area and workspace routinely as required.

Agents are to provide an approved pad for all stockpiles. The stockpiles are to be clearly identified with aggregate supplier code and material type.

3. QUALITY CONTROL

This section outlines the minimum measures that must be implemented and maintained. Measures exceeding these minimum standards may be required by the DME/DMM or the LTS.

A. Quality Requirement Tests

(1) Quality Control Tests

Perform strength ratio, soundness, and abrasion tests at intervals sufficient to ensure the quality of the material. The tests for strength ratio, soundness, and abrasion tests may be performed by the producer or by an independent laboratory. Document the results of tests made during production and make them available to the Department upon request.

(2) Annual Quality Requirement Tests

Obtain and test samples of the source product for the various quality requirements of Pub. 408, Section 703, at the minimum frequency as indicated below. Testing may be performed by the producer or by an independent laboratory. Provide copies of the producer or independent laboratory test results to the DME/DMM and LTS. Take appropriate action to assure that only materials meeting Department requirements are provided to the Department.

Coarse Aggregate-

If requalification samples are not scheduled to be collected during the calendar year, obtain and test materials according to the following table for that calendar year (samples may be collected at any time during the calendar year).

TABLE 1
Required Coarse Aggregate Quality Parameters to be Determined by Aggregate Producers During Calendar Years When Department Requalification Samples are Not Scheduled to be Obtained

Quality Parameter	Test Method	AASHTO No. 8 Coarse Aggregate	All Other Sizes of Coarse Aggregates
Specific gravity and absorption	AASHTO T 85	Required	Required
Sodium sulfate soundness	PTM No. 510	Required	Required
Los Angeles abrasion	AASHTO T 96	Required	Required
Crushed fragments	ASTM D5821	Required	Required
Unit weight	AASHTO T 19	Required	Required
Thin and elongated	ASTM D4791	Required	Required
Petrographic analysis	PTM No. 518	Required	Not Required

If requalification samples are scheduled to be collected during the calendar year, a split sample of the requalification sample must be tested for specific gravity and absorption, sodium sulfate soundness, and Los Angeles abrasion.

Fine Aggregate-

If requalification samples are not scheduled to be collected during the calendar year, obtain and test materials according to the following table for that calendar year (samples may be collected at any time during the calendar year):

TABLE 2
Required Fine Aggregate Quality Parameters to be Determined by Aggregate Producers During Calendar Years When Department Requalification Samples are Not Scheduled to be Obtained

Quality Parameter	Test Method	Cement Concrete Sand Fine Aggregate	Bituminous Concrete Sand Fine Aggregate
Specific gravity and absorption	AASHTO T 84	Required	Required
Sodium sulfate soundness	PTM No. 510	Required	Required
Uncompacted voids	AASHTO T 304	Required	Required
Unit weight	AASHTO T 19	Required	Required
Petrographic analysis	PTM No. 518	Required	Required
Strength ratio	AASHTO T 21	Required	Not Required
Sand equivalency	AASHTO T 176	Not Required	Required

If requalification samples are scheduled to be collected during the calendar year, a split sample of the requalification sample must be tested for specific gravity and absorption, and sodium sulfate soundness.

B. Quality Control Plan
Prepare and submit a Quality Control Plan (QCP), for initial source approval and annually thereafter or as otherwise required, to the DME/DMM for the aggregate production and testing process to assure compliance with specification requirements. A new QCP must be submitted if there are changes made to production, such as the addition of AASHTO # 57 or AASHTO #8. Meet the minimum QCP requirements as set forth in Pub. 2, Project Office Manual, for Aggregate Suppliers. Establish and positively identify aggregate stockpiles which have been tested in accordance with the approved QCP and meet Department specifications. Ensure that material not meeting Department specification is isolated from all stockpiles intended for Department use. Assure that all personnel involved in the production, stockpiling, and the shipping process are advised of quality control measures and proper stockpile identification.

C. Quality Control Technician
Provide, and assign to the work, a PENNDOT Certified Aggregate Technician properly instructed and trained to perform all required quality control tests. Allow the technician(s) sufficient time, free of any additional unrelated conflicting work, to assure compliance with the specification requirements and the QCP. Publication 725 outlines the aggregate technician certification requirements and process. The technician is responsible for, but not limited to, the following duties:

- Assist in development of the QCP as required
- Be cognizant of production quality levels of the source and quality parameters required to maintain source approval
- Lift and test quality control samples
- Document test results made during production in plant records within 24 hours of obtaining results
- Review and discuss test results and production processes with Department representatives as needed
- Assist the Department representatives in sampling and testing as needed
- Take appropriate action to ensure that the production process is controlled so that aggregate is in compliance with the specifications and requirements.
- Prepare and supply certifications for material shipped when required.
- Control and direct loading operations so that only aggregates from identified and approved stockpiles are shipped to the appropriate Department projects
- Control and direct loading operations so that stockpiles are properly mixed to provide consistent, non-segregated aggregate to the Department.
- Control and direct loading operations so that aggregate is properly loaded in trucks with beds sufficiently clean to prevent any contamination of the aggregate.
- Delegate to other properly trained personnel these duties when necessary, while maintaining supervision and responsibility.
- Identify and reject any aggregate not meeting specifications and take appropriate action to prevent shipment of any non-specification aggregate to any Department project.
- Maintain and calibrate test equipment as required.
- Maintain necessary skills and qualifications to perform QC technician duties to the satisfaction of the DME/DMM.

SAMPLES

A. Sample Types

(1) Preliminary Samples (Sample Class: PS) are obtained from a prospective aggregate source where there is no crushing and screening plant in operation and the material is processed at some other location. It is permissible to have several truckloads of the unprocessed material hauled to another operating plant location to be processed into the appropriate aggregate sizes. These test results, however, will not constitute final approval.

(2) Qualification Samples (Sample Class: QS) are obtained from new aggregate sources where a crushing and screening plant is in operation and sufficient material (minimum 200 tons of each aggregate size intended to be produced) has been processed and stockpiled. QS samples could also be obtained from an existing approved aggregate source for any aggregate size not currently approved, but where the producer is seeking approval of this aggregate size for approval. Such samples will not be evaluated more frequently than quarterly and will not be evaluated if the existing approved source has previous failing test results on approved aggregate products that have not been addressed. Address previous failing test results by conducting an investigation and submitting an investigation report to the DME with a copy forwarded to LTS. Include in the investigation report: cause of failure, corrective action, passing independent lab results, site map with area of work, etc. After the report is approved by the District in consultation with the LTS, and corrective action is taken, the District will resample the material.

(3) Requalification Samples (Sample Class: RS) are obtained at least biennially (every two years) from each aggregate source and of each aggregate material or size approved and listed in Bulletin 14 to maintain approval in Bulletin 14 for each source and material. The requalification samples may be obtained at any time during the year from the source of supply. For those sources that have a previous test result history showing test results at or near the acceptable limits of the specification requirements, or when there is any indication that the quality of the material has changed, the frequency of requalification or investigational sampling will be increased to a level that will assure the Department of acceptable quality.

(4) Quality Assurance (Sample Class: QA) samples may be obtained by the Construction Quality Assurance Section (CQAS), Bureau of Project Delivery. QA samples are obtained at the discretion of the Department to assure quality levels.

(5) Independent Assurance (Sample Class: IA) samples may be obtained by the Construction Quality Assurance Section (CQAS), Bureau of Project Delivery. IA samples are obtained at the discretion of the Department to provide an unbiased, independent evaluation of the technicians, sampling and testing procedures, and the equipment used in the acceptance program.

All Preliminary, Qualification and Requalification Samples will be tested at the LTS, in Harrisburg, PA. The sampling must be performed by or witnessed by Department personnel. The samples must be accompanied by a correctly completed Form TR-447 - Sample Identification. The TR-447 Forms for Requalification samples must also show the Bulletin 14 Supplier Code for the source. In addition, Form TR-430A, "Aggregate Source Evaluation Report", shall be completed and sent to the LTS. A file copy shall be retained by the DME/DMM. Sources will not be listed in Bulletin 14 without Form TR-430A on file at the LTS with the DME/DMM's recommended approval indicated on the Form TR-430A.

B. Sample Size

Sample size includes the number of sample increments (i.e., bags) and the quantity of material in each bag and is dependent on the type of aggregate (fine or coarse), aggregate quality, sample classification, and aggregate size (e.g., AASHTO No. 8). Obtain the sample increments by random sampling procedures from stockpiles at either the source or at point of delivery. When specified, use PTM No. 1 for selecting random samples. When obtaining samples of aggregate, the stockpiles of processed material must be sampled according to PTM No. 607 so that the gradation of the samples will accurately represent the gradation of the stockpiled material. Obtain aggregate samples consisting of the following minimum quantities for each type and size listed below:

TABLE 3 Sample Size by Aggregate Type, Quality Level, Sample Class, and Size Designation				
Aggregate	**Aggregate Quality Type (Type A, B, C, or S)**	**Sample Class (QS or RS)**	**Aggregate Size**	**No. of Bags (50 lbs./bag)**
Fine Aggregate	A, B, and C	Qualification Sample (QS)	Each Size	3
		Requalification Sample (RS)	Each Size	1
Coarse Aggregate	A and B	Qualification Sample (QS)	AASHTO No. 8 (# 8)*	7 or 3*
			AASHTO No. 57 (# 57)*	8
	C and S	Qualification Sample (QS)	AASHTO No. 8 (# 8)	3
			AASHTO No. 57 (# 57)	4
			PennDOT No. 2A	6
	A and B	Requalification Sample (RS)	AASHTO No. 8 (# 8)	3
			AASHTO No. 57 (# 57)	4
	C and S	Requalification Sample (RS)	AASHTO No. 8 (# 8)	3
			AASHTO No. 57 (# 57)	4
			PennDOT No. 2A	6
Select Granular Material (2RC)	All Types	All Sample Classes (QS and RS)**	2RC	2
Anti-Skid Material	All Types	All Sample Classes (QS and RS)	Each Size	2
Rock Lining	All Types***	All Sample Classes (QS and RS)	Submit R-3 Size to Represent all Sizes	2
* If both AASHTO No. 8 (#8) and AASHTO No. 57 (#57) are submitted at the same time, four sample increments (i.e., 4 bags) may be omitted from the AASHTO No. 8 (#8).				
** If the Select Granular Material (2RC) source location is an existing approved aggregate source listed in Bulletin 14, no samples are required to be obtained for quality testing.				
*** If the Rock Lining source location is an existing approved Type A, Coarse Aggregate source listed in Bulletin 14, no samples are required to be obtained for quality testing.				

C. Test Results

Aggregate quality testing will require at least 60 days for completion and reporting from time of arrival of samples at the LTS. Upon completion of all required quality testing, an evaluation of the test result data will be made to determine the acceptability of the aggregate for its intended use.

Conformity with the specified gradations of Publication 408 Section 703 is required. When the gradation or wash test of the sample deviate significantly from the specified limits, the results of the quality testing may be affected. The DME/DMM will be notified to resample when it is determined that the results are questionable.

The value (test results) shown for specific gravity and absorption are as recent as the Lab number code indicates (the first two numbers are the year code). Test results from samples will be sent from the LTS to the producer and the DME/DMM submitting the samples. These results will be used to determine conformance with the specifications.

If the sample fails, the producer may contact the DME/DMM to discuss the areas in which the aggregate failed to comply.

FINAL APPROVAL PROCESS\AGGREGATE SOURCE LISTING\REQUALIFICATION PROCESS

Source approval will be granted when the facilities, equipment and processing plant are in place, as required, and material from actual production has been tested for quality and gradation and found to be in compliance with all specification requirements.

If a qualification sample (Sample Class: QS) fails on the gradation or wash test, the failure is to be investigated at the source by the responsible District. After the source makes changes in processing, samples of newly processed material are tested either at the source or at the LTS to verify the material meets specification requirements for these tests.

If a qualification sample (Sample Class: QS) fails on any quality test referenced in Table A (Fine Aggregate Quality Requirements) and Table B (Coarse Aggregate Quality Requirements) in Publication 408, Section 703, the DME/DMM is to notify the source to take corrective action. After the source takes corrective action and produces new material, the DME/DMM will resample (N=3) the new material as soon as possible and notify the LTS.

Initially, the District approves the aggregate source based upon its investigation of the source and the LTS test results. Form TR-430A and a letter requesting listing in Bulletin 14 are to be sent by the responsible District to the Bureau of Project Delivery.

Requalification samples (Sample Class: RS) are taken by the DME/DMM biennially (every two years) as a minimum. Requalification samples may be taken and tested for quality requirements more frequently depending on the source's historical test results. Requalification samples are subject to testing based on the requirements of Publication 408, Section 703. Quality assurance (Sample Class: QA) samples may be taken on a random basis and may be tested for quality requirements.

QUALITY TEST FAILURE PROCESS

Step 1. Requalification sample (Sample Class: RS) or Quality Assurance sample (Sample Class: QA) fails on the gradation or wash test, the failure is to be investigated at the source by the responsible District. After the source makes changes in processing and produces additional material, samples of newly processed material are collected at the source and tested either at the source or at the LTS to verify the material meets specification requirements for these tests.

Step 2. Requalification sample (Sample Class: RS) or Quality Assurance sample (Sample Class: QA) fails on any quality test referenced in Publication 408, Section 703, Table A (Fine Aggregate Quality Requirements), Table B (Coarse Aggregate Quality Requirements), Section 703.3 (Select Granular Material Quality Requirements), or Section 703.4 (Anti-Skid Material Quality Requirements), the DME/DMM is to notify the source to take immediate corrective action. After the source takes corrective action and produces new material, the DME/DMM is to resample (N=3) (Sample Class: IV) the new material as soon as possible and notify the LTS.

Step 3. If all the resamples from Step 2 pass, resample (N=3)(Sample Class: IV) the material at least quarterly during the next six months of new production to ensure there is not a quality problem. Calculate the percent within limits (PWL) for the material based on the last five-year history and if it is below 90%, go to STEP 4. PWL is based on only LTS test results for any quality test referenced in Publication 408, Section 703, in Table A (Fine Aggregate Quality Requirements), Table B (Coarse Aggregate Quality Requirements), Section 703.3 (Select Granular Material Quality Requirements), or Section 703.4 (Anti-Skid Material Quality Requirements).

Step 4. If any one of the three resamples from Steps 2 or 3 fails or if the PWL (based on the last five-year history) for the material falls below 90%, LTS may suspend the source from Bulletin 14 for the specific material (Material Code and Material Class) involved. The source is to investigate the problem and present a written report to the responsible District within 3 months or contact the District. A copy is to be forwarded to LTS. If the source cannot complete its investigation and present a written report within 90 days, provide a written notification to the responsible District when the investigation and written report will be presented to the responsible District (not to exceed 180 days). The report is to include: causes of failures, corrective actions, dates when corrective actions were or are to be completed, passing private lab results, site map with area of work, etc. After the report is approved by the District in consultation with the LTS, and corrective action is taken and new material produced, the District will resample (N=3) (Sample Class: IV) the new material. If warranted, the Bureau of Project Delivery may recommend the establishment of a new historical data base. During the suspension, the source may ship the specific material (Material Code and Material Class) at a lower quality type if it meets all the quality requirements of the lower quality type.

Step 5. If all resamples from STEP 4 pass, the suspension of the source may be lifted. Resample (N=3) (Sample Class: IV) at least quarterly for the next twelve months of new production to ensure there is not a quality problem. Go to STEP 6.

Step 6. If any samples from STEP 4 or 5 fail, calculate the PWL (based on the last ten years of history) and if it is below 90%, the source and the specific material (Material Code and Material Class) is to be downgraded to a quality type level where the material meets requirements or the specific material from the source will be removed from Bulletin 14. The Bureau of Project Delivery will notify the source regarding downgrading or removal.

MAINTAINING APPROVAL STATUS

After approval by the LTS, by letter, the source will remain on the approved list until it is removed for any of the following reasons:

1. Any actions or inactions that may affect the quality of the product, the integrity of the testing results or the applicable quality control plan.

2. Material fails to meet specification requirements.

3. Failure to maintain an effective quality control plan.

4. Operations remain inactive for two years.

5. Major changes are made in processing equipment or operating procedures that degrade the quality of the aggregate.

6. Failure to meet/comply with Publication 408, Section 106.03(a)2.a thru 2.f.

7. Actions relative to the Quality Test Failure Process listed above.

8. Failure to have a PennDOT certified aggregate technician perform and document testing, and manage the quality control process as required in the QUALITY CONTROL section above.

9. At the request of the aggregate producer to be removed.

The DME/DMM will recommend source approvals, suspensions, removals, or quality type downgrades or upgrades to the LTS. The LTS will have final authority regarding approvals, suspensions, removals, quality downgrades or upgrades.

UPGRADING AN AGGREGATE TYPE

The request to upgrade an aggregate type must be submitted in writing to the DME/DMM. Along with this request, the aggregate producer must submit a written report to the District and a copy is to be forwarded to the LTS. The report is to include: corrective action (if upgrade request is due to a previous downgrading of aggregate type), passing independent lab results meeting the upgraded quality type specification requirements, site work with area of work where the aggregate is being mined, dredged, or acquired, QC Plan, etc.

After the report is approved by the District in consultation with the LTS and corrective action is taken (if required), one sample will be obtained by a Department Representative once per month for six consecutive months for a total of 6 samples. All six samples will be tested for quality at the LTS.

The percent within limits (PWL) will be calculated on the six samples. If the PWL is above 90%, the aggregate will be upgraded. If warranted the Bureau of Project Delivery may recommend the establishment of a new historical data start point (date) to represent the current quality of material or production process of the aggregate source.

BIDDING

To receive bid proposals, request an application from the Department of General Services, Bureau of Procurement, 555 Walnut Street, 6th floor Forum Place, Harrisburg, PA 17101

CODE IDENTIFICATION

Supplier Code:

XXX01ABB

XXX – Producer
01 – County or State code
A – Source Identification
BB- Bulletin Code

Materials Code:

203 = Coarse Aggregate
207 = Fine Aggregate
249 = Antiskid (Numbers following are Type e.g. AS1, AS2, AS3 and AS4 etc.)
283 = Rock Lining

Materials Class

A = Stone Type A
B = Stone Type B
C = Stone Type C

Rock Type:

GL = Gravel
SL = Slag
RL = Rock Lining
LW 3/4 = Coarse Aggregate, Lightweight
LW 1/2 = Coarse Aggregate, Lightweight
LW4 = Fine Aggregate, Lightweight
If None Shown the Default is Stone

Examples:

203 A8 = coarse aggregate #8 stone
203 C2A = coarse aggregate #2A stone
203 A8SL = coarse aggregate #8 slag
203 A57GL = coarse aggregate #57 gravel
203 LW3/4 = coarse aggregate light weight 19.0mm (3/4 in.) nominal
207 B = fine aggregate type B
249 AS1, AS2, AS3, AS4 = antiskid type(s) AS1, AS2, AS3, AS4

MATERIAL CLASSIFICATION BY COMPOSITION

AR	=	Argillite	MRX	=	Metamorphic Rocks (General)
AM	=	Amphibolite	MTB	=	Metabentonite
BA	=	Bottom Ash (Cinders)	PH	=	Phyllite
BL	=	Basalt	QZ	=	Quartzite
BS	=	Boiler Slag (Wet Bottom)	QS	=	Quartz Sand
CG	=	Conglomerate	RD	=	Anthracite Red Dog
CH	=	Chert	RSG	=	Reclaimed Granulated Slag
CB	=	Coal Mine Waste (Culm Bank)	RY	=	Rhyolite
CSS	=	Calcareous Sandstone	SB	=	Blast Furnace Slag
DI	=	Diabase	SBMA	=	Spent Bed Mat'l. - Anth.
DO	=	Dolomite	SBMB	=	Spent Bed Mat'l. - Bit
FS	=	Foundry Sand	SC	=	Schist
GB	=	Gabbro	SG	=	Granulated Slag
GD	=	Granodiorite	SH	=	Shale
GL	=	Gravel	SHSL	=	Shaly Laminated Siltstone
GN	=	Gneiss	SL	=	Siltstone
HF	=	Hornfels	SR	=	Serpentine
IRX	=	Igneous Rocks (General)	SS	=	Sandstone
LS	=	Limestone	SO	=	Steel Slag (Open Hearth)
LW	=	Light Weight Aggregate	SM	=	Molybdenum Slag
MB	=	Marble	RC	=	Recycled Concrete

NOTE: Petrographic comparison (P) with samples of satisfactory quality from the same source may be substituted for sodium sulfate soundness (SODS) at the discretion of LTS. Otherwise results are given as Percent (%) Loss.

COUNTY CODE IDENTIFICATION

County	Dist. No.	County	Dist. No.
01 Adams	8-1	34 Juniata	2-9
02 Allegheny	11-1	35 Lackawanna	4-2
03 Armstrong	10-1	36 Lancaster	8-7
04 Beaver	11-2	37 Lawrence	11-4
05 Bedford	9-1	38 Lebanon	8-8
06 Berks	5-1	39 Lehigh	5-3
07 Blair	9-2	40 Luzerne	4-3
08 Bradford	3-9	41 Lycoming	3-2
09 Bucks	6-1	42 McKean	2-5
10 Butler	10-2	43 Mercer	1-4
11 Cambria	9-3	44 Mifflin	2-7
12 Cameron	2-4	45 Monroe	5-4
13 Carbon	5-2	46 Montgomery	6-4
14 Centre	2-1	47 Montour	3-3
15 Chester	6-2	48 Northampton	5-5
16 Clarion	10-3	49 Northumberland	3-4
17 Clearfield	2-2	50 Perry	8-9
18 Clinton	2-3	51 Pike	4-4
19 Columbia	3-1	52 Potter	2-6
20 Crawford	1-1	53 Schuylkill	5-6
21 Cumberland	8-2	54 Snyder	3-5
22 Dauphin	8-5	55 Somerset	9-7
23 Delaware	6-3	56 Sullivan	3-6
24 Elk	2-8	57 Susquehanna	4-5
25 Erie	1-2	58 Tioga	3-7
26 Fayette	12-1	59 Union	3-8
27 Forest	1-3	60 Venango	1-5
28 Franklin	8-3	61 Warren	1-6
29 Fulton	9-4	62 Washington	12-4
30 Green	12-2	63 Wayne	4-6
31 Huntingdon	9-5	64 Westmoreland	12-5
32 Indiana	10-4	65 Wyoming	4-7
33 Jefferson	10-5	66 York	8-4
		67 Philadelphia	6-5

STATE CODE IDENTIFICATION

The same as the Postal two letter code, e.g. NY = New York and OH = Ohio
For Canadian or other foreign sources the following code(s) are used: OT = Ontario

SKID RESISTANCE LEVEL (SRL)

Aggregate Friction Guidelines for Bituminous Wearing Surfaces

The coarse aggregate used in bituminous wearing surfaces or the fine aggregate, in the case of FJ-1 Wearing surfaces, shall have the following aggregate Skid Resistance Level (SRL) letter designation based on the current Average Daily Traffic (ADT) for resurfacing and anticipated initial Daily Traffic on new facilities.

A D T	S R L
20,000 and above	E
5,000 to 20,000	E, H, Blend of E & M,or Blend of E & G.
3, 000 to 5,000	E, H, G, Blend of H & M,or Blend of E & L
1,000 to 3,000	E, H, M, G, Blend of H & L,or Blend of G & L OR Blend of E & L
1,000 and below	A N Y

*All blends are 50% by weight and shall be made by an approved method of blending.

Using the above guidelines, special provisions for contracts or purchase orders shall be prepared stating the aggregate SRL letter designation and/or SRL Blend requirements.

SKID RESISTANCE AGGREGATE TYPES

SRL	Aggregate Type
E	Sandstones; siltstones; Loyalhanna Limestone sources (calcareous sandstones) which consistently contain more than 30% + #200 acid insoluble residue; gneisses and igneous rocks which contain high amounts of micas; several quartzite sources which have been sheared so that they have softer, sheared microcrystalline quartz surrounding the remaining intact quartz grains; and gravels which contain either a.) < 25% carbonates, < 10% chert, and high percentages of dirty sandstones and siltstones; or b.) < 10% carbonates, < 15% chert, and high percentages of dirty sandstone and siltstones.
H	Argillites; diabases, gneisses, granites and granodiorites, basalts, and gabbros which do not contain large amounts of micas; open hearth slag; blast furnace slag; metamorphic quartzites (no difference in hardness between quartz cement and quartz grains); sandy limestones; a few coarsely crystalline dolomites (e.g., the Ledger dolomite); and gravels which contain either: a.) > 25% and < 34% total carbonates, and <10% chert; or b.) > 15% chert and < 25% chert, and < 10% carbonates; or c.) large amounts of quartzite.
G	Siliceous limestone and dolomite; limestones and dolomites with consistent wide textural variation (i.e., they always contain finely to moderately or coarsely crystalline dolomite or limestone); gravels which contain more than 34% carbonates and more than 10% chert; and serpentinites.
M	Many dolomites and some limestones that are not consistently finely textured all the time.
L	Most limestones and some dolomites that are very finely textured, and contain very little, if any, acid insoluble residue retained on the #200 sieve

RE-EVALUATING SRL RATINGS USING RIBBED TIRE SKID DATA

PROCESS Aggregate Producer Responsibilities:

1. Compile a list of at least ten to twelve 9.5 mm (3/8”) Nominal Maximum Aggregate Size (NMAS) asphalt mixture wearing courses, including the following information for each roadway:
   a. State Route (S.R.) Number (4-digit number) or, if Municipal roadway, roadway name (e.g., Murphy Road) and/or designation (e.g., T-321),
   b. County
   c. Municipality (if roadway / roadway segments are Municipal roadways),
   d. Beginning and ending roadway Segment/Offsets or, if Municipal Roadway, beginning and ending points (landmarks, intersecting roadways, etc.),
   e. Bituminous Job Mix Formula (JMF) for each roadway / roadway segment,
   f. Average Daily Traffic (ADT) of the roadway / roadway segments.
      i. If the ADT is unknown (e.g., Municipal roadways), a consultant engineering service must be hired by the Producer to measure the ADT. The privately obtained traffic counts must be conducted over a 24-hour period of maximum traffic, preferably during the period of a Tuesday through Thursday from midnight to midnight. The traffic count shall be a combination of a classification count and a volume count (see Note 1).
   g. The 10-12 roadways / roadway segments must meet the requirements listed in the Requirements of the roadway / roadway segments section below.

   Note 1:
   A. Classification count – counts the number of different classes of vehicles in each lane in each direction.
   B. Volume count – for a divided road, a volume count obtains a count for each direction across all lanes, but not on individual lanes. For an undivided road, a volume count obtains the total volume on all lanes in both directions.
2. Gather and prepare roadway maps detailing location of each roadway /roadway segment and specifically showing the beginning and ending points of each roadway / roadway segments in each direction.
3. Prepare a letter to the responsible District Materials Engineer/District Materials Manager (DME/DMM) requesting SRL re-evaluation. The letter is to include the aggregate supplier company name, location, and supplier code of the aggregate source to be evaluated as identified in PennDOT Publication 34, Bulletin 14. The letter is to be addressed to the DME/DMM responsible for the aggregate source location.
4. Submit the letter and two copies of both the list of roadways and maps to the DME/DMM. It is highly recommended to submit the list of roadways and maps at the beginning of the calendar year as ribbed tire testing for SRL re-evaluation is only performed from June 15 to November 15 each year.
5. When requested, obtain 6-inch diameter pavement core samples from the roadways / roadway segments and/or specific locations as requested by the Department for further Department analysis. Coordinate obtaining the pavement cores with the Engineering District (RMS Unit) responsible for the roadways / roadway segments. A Department Representative from the Pavement Design Unit must be present during drilling of the pavement cores and will take immediate possession of the pavement cores.

Requirements of the roadway/roadway segments to be submitted for SRL reevaluation:

1. Must have a wearing course with a 9.5 mm (3/8") NMAS.
2. Must be under traffic for at least one year.
3. Must be at least ¼ mile long.
4. Virgin coarse aggregate in the wearing course asphalt mixture must be 100% from the aggregate source for which producer wants the SRL rating re-evaluated. If any of the wearing courses that the aggregate producer wants to submit for SRL re-evaluation contain RAP, the mix design and the gradation of all the aggregates and the RAP used in the mix design must be submitted to the LTS for evaluation of the suitability of the mix design for skid testing before any wearing courses laid using that mix design can be accepted for skid testing. Any JMF-containing RAP in which aggregate from the RAP contributes 10% or more of the total blended aggregate retained on the #4 sieve will be rejected for use for SRL re-evaluations.
5. ADT of entire length of roadway where the wearing course is located must be known. ADT along a length of roadway may be affected and different due to intersecting roadways located between the beginning and ending points of the roadway. If a selected roadway / roadway segment contains intersecting roadways, provide the ADT of the selected roadway / roadway segment between each of the intersecting roadways.
6. Cannot have rutting exceeding a maximum depth of 3/8" at any location (includes rutting from buggy traffic, farm traffic, plastic deformation of the pavement layers under traffic, or improper or inadequate pavement base support).
7. Cannot have more than 10% of the area of the wheel paths that consist of repairs or patching.
8. Cannot have any cracking due to base failure.
9. Within the 10-12 roadways / roadway segments submitted for the SRL re-evaluation, the roadways must have a range of ADTs in order to assist the analysis with extrapolating the SRL above the existing SRL level.

Department Responsibilities:

1. The Engineering District responsible for the roadways / roadway segments will review the list of roadways / roadway segments and maps submitted and verify or complete the ADT for each roadway / roadway segment using ADT data from the Roadway Management System (RMS) or other District ADT data.
2. LTS will request locked-wheel skid testing from the Bureau of Maintenance & Operations on all the roadways / roadway segments.
3. LTS will analyze the skid data.
    a. If the data has a defined aggregate performance, then a letter is sent to the producer with results of the re-evaluation.
    b. If the data gives inconclusive aggregate performance, then a letter is sent notifying the producer of what additional work needs done. This typically includes obtaining 6-inch diameter pavement cores from each of the 10-12 roadways / roadway segments submitted or from a specific number of the 10-12 roadways / roadways segments submitted.
    c. The Engineering District (RMS Unit) responsible for the roadways / roadway segments will submit any collected pavement core samples to the District Construction Materials Unit. The District Materials Engineer/Manager will submit the pavement cores to LTS. Submit pavement core sample identification information through eCAMMS using Material Code 218 (Concrete Core), Material Class BTMNS, and Sample Class IF-Information.
        i. Upon submission of requested pavement cores from the roadway segments that were skid-tested. The LTS will extract the asphalt from the cores using solvent extraction. The extracted aggregates will be evaluated. A letter will be sent to the producer with the results of the re-evaluation.

eCAMMS

- Click a tab to locate approved materials in Bulletin 14 (Aggregate), Bulletin 15 (Qualified Products List for Construction), Bulletin 41 (Bituminous) or Bulletin 42 (Concrete).
- Enter search criteria in one or more fields. Click Search to view the results. Click Reset to start over.
- Map views are not available for searches performed with the Address filter. Map views only display results for Suppliers who have map coordinates on file and may not represent all search results.

Bulletin – Search Criteria

Bulletin 14 (Aggregate) | Bulletin 15 (Qualified Products List for Construction) | Bulletin 41 (Bituminous) | Bulletin 42 (Concrete)

Supplier Name:

Supporting Information (PDF)

Supplier Code: HAP47A14

Material Code/Class:

To search all Suppliers, regardless of location, do not include a Map or Address filter.

Map Location / Address: Map Location Address

Search Reset Show All

Search Results

Compare Select All Clear Selection

7 Products Found

- To display item details, click the arrow (>) beside one or more rows. To view the details for all rows, click the arrow (>) at the top of grid.
- To compare details side-by-side, click the checkboxes beside two or more rows. Click Compare.
- Click Select All to select all results. Click Clear Selection to clear all selections.

Supplier Name	Supplier Code	Material Code	Material Class	Location	Status
Hanson Aggregates Pennsylvania LLC	HAP47A14	203	A57	MILTON #2	Approved
Hanson Aggregates Pennsylvania LLC	HAP47A14	203	A8	MILTON #2	Approved
Hanson Aggregates Pennsylvania LLC	HAP47A14	249	AS1	MILTON #2	Approved
Hanson Aggregates Pennsylvania LLC	HAP47A14	249	AS2	MILTON #2	Approved
Hanson Aggregates Pennsylvania LLC	HAP47A14	249	AS3	MILTON #2	Approved
Hanson Aggregates Pennsylvania LLC	HAP47A14	207	B3	MILTON #2	Approved
Hanson Aggregates Pennsylvania LLC	HAP47A14	203	S2A	MILTON #2	Approved

- Click a tab to locate approved materials in Bulletin 14 (Aggregate), Bulletin 15 (Qualified Products List for Construction), Bulletin 41 (Bituminous) or Bulletin 42 (Concrete).
- Enter search criteria in one or more fields. Click Search to view the results. Click Reset to start over.
- Map views are not available for searches performed with the Address filter. Map views only display results for Suppliers who have map coordinates on file and may not represent all search results.

Bulletin - Search Criteria

Bulletin 14 (Aggregate) | Bulletin 15 (Qualified Products List for Construction) | Bulletin 41 (Bituminous) | Bulletin 42 (Concrete)

Supplier Name:

Supplier Code: HAP47A14

Material Code/Class:

Supporting Information (PDF)

To search all Suppliers, regardless of location, do not include a Map or Address filter.

Map Location / Address: Map Location Address

Search Reset Show All

Search Results

Compare Select All Clear Selection

7 Products Found

- To display item details, click the arrow (>) beside one or more rows. To view the details for all rows, click the arrow (>) at the top of grid.
- To compare details side-by-side, click the checkboxes beside two or more rows. Click Compare.
- Click Select All to select all results. Click Clear Selection to clear all selections.

Supplier Name	Supplier Code	Material Code	Material Class	Location	Status
Hanson Aggregates Pennsylvania LLC	HAP47A14	203	A57	MILTON #2	Approved

Approval Date: 3/10/2021

Primary Address: Hanson Aggregates Pennsylvania LLC
7660 Imperial Way
Allentown, PA 18195

Physical Address:

Phone Number:

Fax Number:

Lab Number: L20030256

Restrictions:

Bulk Specific Gravity (SSD):	2.679	Bulk Specific Gravity:	2.653
Absorption:	0.97	Sodium Sulfate Soundness:	5 %
Alkali-Silica Reactivity (ASR) AASHTO T303 :		Alkali-Silica Reactivity (ASR) ASTM C1293 :	0.046
AASHTO T303 Reactivity Class :		ASTM C1293 Reactivity Class :	R1
Uncompacted Voids:		Sand Equivalency:	
Rock Compositions & Order Of Abundance:	LS (Limestone): 1	Skid Resistance Level Type:	L
		Micro-Deval Loss:	21
Los Angeles Abrasion:	22	Crush Count % 2-Face:	
Crush Count % 1-Face:		Notes:	
Thin & Elongated Pieces (5:1):	4		

Supplier Name	Supplier Code	Material Code	Material Class	Location	Status
Hanson Aggregates Pennsylvania LLC	HAP47A14	203	A8	MILTON #2	Approved
Hanson Aggregates Pennsylvania LLC	HAP47A14	249	AS1	MILTON #2	Approved
Hanson Aggregates Pennsylvania LLC	HAP47A14	249	AS2	MILTON #2	Approved

- Click a tab to locate approved materials in Bulletin 14 (Aggregate), Bulletin 15 (Qualified Products List for Construction), Bulletin 41 (Bituminous) or Bulletin 42 (Concrete).
- Enter search criteria in one or more fields. Click Search to view the results. Click Reset to start over.
- Map views are not available for searches performed with the Address filter. Map views only display results for Suppliers who have map coordinates on file and may not represent all search results.

Bulletin – Search Criteria

Bulletin 14 (Aggregate) | Bulletin 15 (Qualified Products List for Construction) | Bulletin 41 (Bituminous) | Bulletin 42 (Concrete)

Supplier Name:

Supporting Information (PDF)

Supplier Code: LOPNYB14

Material Code/Class:

To search all Suppliers, regardless of location, do not include a Map or Address filter.

Map Location / Address: Map Location Address

Search Reset Show All

Search Results

Compare Select All Clear Selection

6 Products Found

- To display item details, click the arrow (>) beside one or more rows. To view the details for all rows, click the arrow (>) at the top of grid.
- To compare details side-by-side, click the checkboxes beside two or more rows. Click Compare.
- Click Select All to select all results. Click Clear Selection to clear all selections.

Supplier Name	Supplier Code	Material Code	Material Class	Location	Status
Lopke, F. S., Contracting, Inc.	LOPNYB14	207	A	OWEGO	Approved
Lopke, F. S., Contracting, Inc.	LOPNYB14	203	A57GL	OWEGO	Approved
Lopke, F. S., Contracting, Inc.	LOPNYB14	203	A8GL	OWEGO	Approved
Lopke, F. S., Contracting, Inc.	LOPNYB14	249	AS2	OWEGO	Approved
Lopke, F. S., Contracting, Inc.	LOPNYB14	249	AS3	OWEGO	Approved
Lopke, F. S., Contracting, Inc.	LOPNYB14	207	B3	OWEGO	Approved

- Click a tab to locate approved materials in Bulletin 14 (Aggregate), Bulletin 15 (Qualified Products List for Construction), Bulletin 41 (Bituminous) or Bulletin 42 (Concrete).
- Enter search criteria in one or more fields. Click Search to view the results. Click Reset to start over.
- Map views are not available for searches performed with the Address filter. Map views only display results for Suppliers who have map coordinates on file and may not represent all search results.

Bulletin – Search Criteria

Bulletin 14 (Aggregate) | Bulletin 15 (Qualified Products List for Construction) | Bulletin 41 (Bituminous) | Bulletin 42 (Concrete)

Supplier Name:

Supporting Information (PDF)

Supplier Code: LOPNYB14

Material Code/Class:

To search all Suppliers, regardless of location, do not include a Map or Address filter.

Map Location / Address: Map Location Address

Search Reset Show All

Search Results

Compare Select All Clear Selection

6 Products Found

- To display item details, click the arrow (>) beside one or more rows. To view the details for all rows, click the arrow (>) at the top of grid.
- To compare details side-by-side, click the checkboxes beside two or more rows. Click Compare.
- Click Select All to select all results. Click Clear Selection to clear all selections.

Supplier Name	Supplier Code	Material Code	Material Class	Location	Status
Lopke, F. S., Contracting, Inc.	LOPNYB14	207	A	OWEGO	Approved
Lopke, F. S., Contracting, Inc.	LOPNYB14	203	A57GL	OWEGO	Approved

Approval Date: 1/23/2020

Primary Address: Lopke, F. S., Contracting, Inc.
3430 State Route 434
Apalachin, NY 13732

Physical Address: Lopke, F. S., Contracting, Inc.
NY

Phone Number:

Fax Number:

Lab Number: L19030823

Restrictions:

Bulk Specific Gravity (SSD):	2.625	Bulk Specific Gravity:	2.585
Absorption:	1.57	Sodium Sulfate Soundness:	2 %
Alkali-Silica Reactivity (ASR) AASHTO T303 :		Alkali-Silica Reactivity (ASR) ASTM C1293 :	0.032
AASHTO T303 Reactivity Class :		ASTM C1293 Reactivity Class :	R0
Uncompacted Voids:		Sand Equivalency:	
Rock Compositions & Order Of Abundance:	GL (Gravel): 1	Skid Resistance Level Type:	H
		Micro-Deval Loss:	16
Los Angeles Abrasion:	18	Crush Count % 2-Face:	88
Crush Count % 1-Face:	93	Notes:	
Thin & Elongated Pieces (5:1):			

Supplier Name	Supplier Code	Material Code	Material Class	Location	Status
Lopke, F. S., Contracting, Inc.	LOPNYB14	203	A8GL	OWEGO	Approved
Lopke, F. S., Contracting, Inc.	LOPNYB14	249	AS2	OWEGO	Approved

Quality Control

VIII. Quality Control/Quality Assurance

A. QC/QA Implementations:

The aggregate technician will be testing the material in the plant laboratory at the increments and sample sizes as outlined by their approved Quality Control Plan. The plant will also receive inspections from the District Materials Engineer or a member of his staff under the provisions of the District Quality Assurance Plan. They will take District Quality Assurance (D.Q.A.) samples and send them to the Laboratory Testing Section (LTS) of PennDOT. The Bureau of Project Delivery Construction Quality Assurance Section will administer the Independent Assurance program at aggregatesources supplying PennDOT construction projects. The Independent Assurance program provides an unbiased and independent evaluation of the sampling and testing personnel, the testing equipment, and the sampling and testing procedures used in PennDOT's aggregate acceptance program. Independent Assurance samples will be tested at PennDOT's LTS and the test results will be compared with companion test results run at the aggregate source to verify the results are within established tolerance limits for gradation, material finer than 200 sieve, and crush count (where applicable).

B. Aggregate Technician Record Keeping:

There are three (3) categories of record keeping that every aggregate supplier must comply with to maintain State approval which are described below. Records are written in ink and kept in the Construction Aggregate Source Documentation Book, sometimes referred to as the Material Plant Book or State Book. The contents of this book are the property of PennDOT and maintained by the aggregate technician. The specifications for Aggregate Plant Records and Documentation are found in the PennDOT "Project Office Manual, Part B, Section 7, pages 15-1-2". Current copies of forms for record keeping can found at www.penndot.gov under "Forms and Publications."

1. **Plant Production:**

   a) Have on file a Quality Control Program approved yearly by PennDOT. The specifications for Minimum Quality Control Plan for Aggregate suppliers are found in the PennDOT Project Office Manual, Part B, Section 7, pages 14-1,2.

   b) Have on file a copy of the Aggregate Source Evaluation Report (Form TR 430A). The Aggregate Source Evaluation Report is completed either annually or biennial depending upon the District.

c) Have on file records of testing all material being produced for State consumption. These results are kept, using Form CS 4211.

d) All gradation recorded on Form CS 4211 are than plotted on a straight-line analysis graph. A straight-line graph must be maintained for each sieve. Additional documentation should be provided detailing procedures that were taken to correct problems.

e) The equipment is to be calibrated in accordance withspecification requirements and the technician must record calibration results on Form CS 4221-E.

f) The aggregate technician must also maintain a record of samples submittedto the Laboratory Testing Section (LTS) using Form CS 4211-E. Some of the information requested on this form will not be available until the results are returned to the plant.

2. Shipments to PennDOT:

a) The aggregate technician must maintain a record of all material being shipped to PennDOT and who released the material. This information is to be recorded on Form CS 4221-C. All material shipped to PennDOT must be released by a PennDOT representative.

b) A project summary will be maintained recording the total tonnage shippedto each job, by type of material shipped. This information is recorded on Form CS 4211-B.

c) The aggregate technician will provide a Certificate of Compliance using the most current Form CS 4171 for each product and each job which has received shipments(s) daily. This is a signed, legal document, certifying that all appropriate testing has been performed and that the material meets specification requirements. The aggregate technician will need to obtain an electronic signature from PennDOT to sign the Certificate of Compliance. Only PennDOT enrolled electronic signatures can be used to signthe Certificate of Compliance.

d) The aggregate technician is also responsible for maintaining a plantsummary (combined daily shipments) on Form CS 4211-D. The Form CS-4211D Plant Summary data is also to be entered in the eCAMMSElectronic State Book under the menu option for Plant Summary Entry. The data must be entered into eCAMMSwithin 48 hours of shipping the aggregate.

e) When anti-skid is being shipped to PennDOT, the aggregate technician is also responsible for testing and recording samples for moisture on Form CS 4221-G.

3. <u>Source Records for Quality Requirements:</u>

Each aggregate producer is required to perform, or have performed by an independent lab, such occasional quality tests as may be necessary to ensure that the product consistently meets the quality requirements for fine or coarse aggregates. This is <u>in addition to</u> biennial requalification testing done by PennDOT.

a) Records of these tests will be kept in an ongoing file, and available for the review with Department representatives at any time.

b) If testing is done on "splits" of PennDOT samples, it will be noted in the report with results included.

c) The reports will indicate date sampled, part of quarry from which the production came, the geological unit, and any other distinctions which are considered important (selective mining situations).

4. <u>District Quality Assurance Aggregate Source Inspections:</u>

This form must be signed by the aggregate technician.

Aggregate Source Documentation Book

WE WILL NOW REVIEW EACH FORM IN DETAIL IN THE SAME SEQUENCE DESCRIBED ABOVE.

SUB ECT

AGGREGATE PLANT RECORDS AND DOCUMENTATION

The Material Plant Book must have the producer s name and plant location on the outside cover. It should be maintained as one book containing one set of test records as documentation for all projects supplied. Form CS-4211, Table of Contents, lists all forms required for the plant book.

The producer is responsible for source documentation and production control in accordance with the approved quality control plan. All testing procedures are found in Publication 19, Field and Laboratory Testing Manual or appropriate AASHTO or ASTM test methods.

Plant Inspector's Documentation

The plant inspector should keep, on a daily basis, Form CS-4346, Items uantity Book, as a Plant Master Diary, in black ink, and shall include the following information:

1. Date, Weather, Temperature Range
2. Inspector s Name, Title, Hours Worked
3. Visitors
4. Material Tests Performed
5. Material Deviations
6. Unusual Occurrences, Comments Concerning Plant Operation, Conditions and Record Keeping
7. Inspector s Signature

Producer's Documentation

The producer is responsible for completing the following forms which constitute the Material Plant Book:

Form CS-4211 Table of Contents
Form CS-4211A Material Test Result Records
Separate copies must be used for each aggregate size.
Form CS-4211B Project Summary Record
Separate sheet for each aggregate type.
Form CS-4211D Plant Summary
Form CS-4211E LTS Sample Submission Record
Form CS-4211I Aggregate No. 57
Form CS-4211 Aggregate No. 8
Form CS-4211K Fine Aggregate
Form CS-4211L Aggregate No. OGS
Form CS-4211M Aggregate No. 67
Form CS-4211N Aggregate No. 2A
Form CS-4221C Daily Orders and Releases Record
Form CS-4221E Equipment Calibration Record (Including PTM 608)
Form CS-4221G Anti-Skid Summary Moisture Record

- The Form CS-4211D Plant Summary data is also to be entered in the eCAMMS Electronic State Book (ESB) under the menu option for Plant Summary Shipment Entry.

The Producer is responsible for entering Plant Summary data into the eCAMMS ESB under the menu option for Plant Summary Shipment Entry. In the eCAMMS ESB, the Producer is to enter daily shipment data under the proper contract type and enter the data within 48 hours of shipping aggregate material.

The Producer s Plant Technician is also responsible for establishing straight line diagrams or statistical quality control charts for each aggregate size which is to include action points for critical test values.

Plot all District/Central Office uality Assurance samples results along with all the companion sample results conducted by the Plant Technician. Comments will be made and documented on all LTS test results compared to companion sample results as to uniformity between laboratories.

Form TR-430A - Aggregate Source Evaluation Report, Technicians Evaluation/NECEPT Certification and a current approved uality Control Plan shall be on file at the Plant.

Production Acceptance

The original producer delivery ticket (or a copy of the recordation ticket) must accompany aggregates released from a quarry or accepted on a project. The ticket must contain the following information:

1. Contract Number, State Route and Section or Purchase Order
2. County and District
3. Type Aggregate
4. Date
5. Truck Number
6. Mass (Weight), Gross, Tare, Net
7. Signature of Licensed Public Weighmaster

REPLACES B.7.14	PENNSYLVANIA DEPARTMENT OF TRANSPORTATION	PART B	SECTION 7	PAGE 14-1
DATED 03/01/2011	**PROJECT OFFICE MANUAL**	DATE **April 1, 2020**		
SUB ECT **MINIMUM QUALITY CONTROL PLAN FOR AGGREGATE SUPPLIERS**				

The producer must submit a quality control plan to the District Materials Engineer/Manager (DME/DMM) annually. The purpose of this requirement is to ensure that the producer will consistently produce a uniform and high quality product within Department specifications.

The following uality Control Plan is a minimum plan designed to these standards.

A. Sampling and Testing Frequencies
The minimum testing frequency for all aggregate types will be at least one sample daily for the first 500 tons and one sample for each additional 1,000 tons. Tests are to include, if applicable:

1. Gradations PTM No. 616
2. Wash Test PTM No. 100
3. Crush Count ASTM D 5821
4. Unit Weight AASHTO T 19 (To be tested twice a year or as required)

Tests other than gradations may be reduced to once weekly after uniformity has been established. For high volume aggregate production such as subbase material, sampling frequency may be increased to 1,000 tons daily and one for each additional 2,000 tons. All changes to sampling/testing frequencies must be approved by the DME/DMM.

B. Department Stockpiles
Establish and positively identify aggregate stockpiles intended for Department use. At a minimum, the respective grading (AASHTO or PennDOT) and specific use (if appropriate) will be provided.

C. Material Failures
Increase production testing frequencies to at least double the minimum required in Section A above until uniformity is established over five consecutive production days. Document all actions taken when failures are noted.

D. Certification
Certify each day s shipments for each aggregate size to each project shipped, as specified in Publication 408, Section 106.03(b)3.

E. Calibration of Mechanical Sieve Shaker
Calibrate mechanical sieve shaker according to PTM No. 608 at the start of the season and when directed.

QUALITY CONTROL PROGRAM - 2021
XYZ Aggregates Inc.
Quality Control Plan for Aggregate -XYZ01A14

The following uality Control Plan is a minimum for the control and acceptance of construction aggregates.

A. Sampling and testing frequencies -

The minimum testing frequency for all aggregate types including Anti-skid will be at least one sample daily for the first 500 tons and one sample for each additional 1,000 tons or portion of. High volume aggregate production such as subbase material sampling the frequency may be increased to 1,000 tons daily and one for each additional 2,000 tons. Tests are to include, if applicable:

If approved in writing by the District Materials Engineer

I. Gradations - PTM 616
2. Wash Test- PTM 100
3. Crush Count - ASTM-D5821
4. Unit Weight - AASHTO T-19 (To be tested at least twice a year or as required)
5. Moisture Content - PTM 513
6. Minimum Strength Ratio - AASHTO-T21 (Requalification year and at least one per month while producing)

Tests other than gradations may be reduced to once per calendar week after uniformity has been established, unless material is used for Concrete, then a wash test MUST be run on every grading. All changes to sampling/testing frequencies must be approved in writing by the District Materials Engineer. For Type A Sand and anti-skid that requires a wash test, one is required with every gradation, follow PTM 616. All gradations will be lifted from either conveyor belt (if able) or mini stockpile adjacent to pile to control gradation (AASHTO T-2).

In the event of blending any aggregates, a front-end loader will mix the material into 500-ton (maximum) stockpiles. They will be tested prior to incorporating into PennDOT stockpiles.

A minimum of two moisture tests per day will be conducted when shipping anti-skid. Additional tests will be conducted when conditions exist which would cause a change in moisture content. Record moisture results and tonnage shipped on Form CS-4171 Materials Certification.

B. Documentation -

The Plant Technician will be responsible for maintaining the following forms in the plant book:

l. Table of Contents
2. TR 430A
3. Technicians Certification
4. C Plan
5. Calibration of Equipment scales, oven, etc.)
6. Orders and Releases
7. Project Summaries (entered in eCAMMS)
8. Plant Summaries (entered in eCAMMS)
9. Aggregate Gradations and Straight Lines
l 0. Anti-skid Summary and Moisture
11. MTD Sample Submission Record
12. Estimate of daily production of aggregate sizes.
13. Annual calibration of mechanical shakers (PTM608) (start of season)

In electronic plant book (backed up daily)

All entries must be complete by the next working day.

B. (1) Documentation-

All District/Central Office quality assurance sample results along with all companion sample results conducted by the Plant Technician will be plotted. Comments will be made and documented on all LTS test results compared to companion sample results as to uniformity between laboratories.

C. Department Stockpiles -

Aggregate stockpiles intended for Department use will be established and positively identified. At a minimum, the respective grading (AASHTO or PennDOT) and specific use (if appropriate) will be provided. Mote-paver and 1% wash spec #8 will be designated when applicable. When shipping from approved isolated stockpiles, test for gradation and wash test, at least once per week.

Driving Surface Aggregate (DSA) - When producing DSA for a state or municipal project, construct the stockpile and notify the District Materials Unit to perform source verification prior to shipping. The stockpile <u>cannot</u> be added to after approval by the District for gradation.

D. Material Failures -

Production testing frequencies will be increased to at least double the minimum required in Section A above until uniformity is established over five consecutive production days. Document all actions taken when failures are noted.

A material failure is defined as follows:
If any single test value is out of specification, immediately resample and test. If the retest passes, no action is required. If the retest fails, another sample and test is required. Evaluate the three test values in accordance with Section 106.03(a)3 to determine the percent within limits. If the sample results indicate a PWL of less than 90 a new stockpile will be constructed. Increased production testing frequencies will be followed as stated above.

E. Action Points -

Action points will be established on the straight-line diagrams or control charts. Documented action will be taken anytime the <u>N=3</u> plot falls into the established action area. Action is also, required whenever the <u>N=3</u> value is within <u>1%</u> of the specification limit for all critical sieves that have a ± tolerance. All actions taken will be documented.

(2)

The following action points from critical test sieves are to be used as a minimum for these aggregate types.

#57-1/2 sieve ± 7% from established target value(42%-target, min. 35% passing-Slip Form Pavement)
- #200 sieve 1.0% max for cement concrete
  0.8% max. for seal coat and surface treatment
  2.0% max. for all other uses

#67 - 3/8 sieve ± 7% from established target value
- #200 sieve - same as #57

#8 - #4 sieve± 4% from established target value
- #200 sieve same as #57

#10 - #100 sieve± 4% from established target value
#200 sieve 8% maximum (if used for flowable fill)

2A - #4 sieve ± 7% from established target value
- #16 sieve± 4%from established target value
- #200 sieve 8% maximum

Anti-Skid (All Types)
-#4 and #8 sieve when within 5% of any spec. limit
-#200 sieve (if required) when within 1% of spec limit

DSA -#4 sieve ± 7% from established target value
- #16 sieve ± 4% from established target value
- #200 sieve 11% minimum, 14% maximum

F. Certification -
Form CS-4171 Materials Certification of Compliance (Dated 3-19)
The technician will certify each day s shipments for each aggregate size to each project shipped in accordance with Section 106.03(b)3. Use Form CS-4171, include supplier code and aggregate quality type (ie: A57, C2A).

For anti-skid shipments show wet tonnage, dry tonnage and percent of moisture.

G. Delivery Ticket -

1. SR and Section or P.O.

2. County and District

3. Type of Aggregate

4. Date

5. Truck Number

6. Weight (Gross, Tare, Net)

7. Penn DOT Supplier Code (Bulletin 14)

8. Signature of Licensed Public Weighmaster (If electronic signature is used, a separate addendum outlining policies and security will be submitted, SOL 421-04-03)

H. Organizational Chart

1. Chief Plant Technician _oe Manager (0001)

2. Assistant Plant Technician(s) Assistant Bill (0002)

   Helper Mike (454545)

   oe Technician (787878)

3. Plant Manager Bill Manager

4. Assistant .C. Manager Brian Manager (1234)

5. Manger of Technical Services Mark Services (2345)

The above listed personnel are those currently assigned to these positions. Changes will be mad e as necessary.

Person(s) responsible for notifying Materials Unit 24 hours prior to shipment.

I. Annual uality Requirement Testing
Required annual tests:

AASHTO T-96	PTM 510	AASHTOT-21
#57	#57	A-Sand
#8 (if applicable)	#8	
	B Sand	
	A Sand	

All results will be forwarded to the DME/DMM. Only material meeting Penn DOT requirements will be provided to the Department. (Per Bulletin 14)

These are the minimum process control requirements and may be added to, or the frequency increased, by the Producer or by the Department Representative, to assure compliance.

The persons named on the uality Control Organizational Chart are solely responsible for implementing the approved uality Control plan and are responsible for material compliance.

ADDENDUM SHEET

TRUCK WEIGHT VERIFICATION

Scope:
As a way of establishing truck weight verification at all locations in District 7-0, Y Aggregate Inc. will randomly select three units per location per month for purposes of checking axle weights. The goal will be to eliminate any vehicles leaving any location with axle weights that do not meet the axle weight standards as set forth by the Department of Transportation. Any vehicles that are found to have deviant axle weights will be required to make immediate adjustments prior to being released from the plant.

Each location will have an individual assigned to oversee this program and ensure that it is carried out to its fullest. The Truck Weigh Record supplied by the Department will be used to record the data.

Also, it is our intention to hold training for the loader operators that will incorporate many issues including the importance of proper truck axle weights.

,A Sampling and Testing Frequency

1. Samplers will be:
   a. Plant licensed weighmaster
   b. and/or Certified Plant Technician

2. Frequency will be:
   1. One test series/month (day selected by samplers)
   2. Three trucks/test (selected by PTM1)

      Note: The intent is to test 3 trucks/day/test
      However, 1 truck/day on 3 different days
      could be substituted by mutual agreement.

8. Documentation
   1. Penn DOT form TWR (6-0) revised 11/97
   2. Prepared by Plant Technician
   3. Maintained in separate section of plant book

C. Reference
   1. Truckers Handbook

D. Overview

This program will be monitored by:
1. Transportation Manager Trucker_oe
2. Technical Services Manager Mark Services

TR-430A (10-73)

AGGREGATE SOURCE EVALUATION REPORT

Purpose: Prelim inary ( ) ualification ( )
Requalification ( ) Investigation ( )
Research ( ) Project ( )

Lab. No. Y 01A14

District 08 Date 06/07/2021

County Adams

Twp. or Boro. Fairfield Twp.

PERMANENT SOURCE

Producer Y Aggregates 1234 Stone Road Fairfield, PA 17000
(NAME AND ADDRESS)

Location. Fairfield uarry
(AS LISTED OR TO BE LISTED IN BULLETIN)

- **TEMPORARY SOURCE** ______ Contractor ______

L.R. ______ Section ______

Location of Aggregate Source: 4 miles from Gettysburg on L.R. or T.R. SR 0030

Sec. ____ Lt. or Rt. ____ Township ____ on Mile Post ____ Pool ____ on ____ River.

Processing Plant. Permanent ( ), Portable ( ), None ( ). If none, name of producer and location where material was processed to provide the samples submitted, if any ______

Superintendent or other contact: Name oe Superintendent Tel. (717) 123-9876

A. This source is proposed for new or continued listing in Bulletin 13 ( ), Bulletin 14,( ), a temporary or project source ( ), or Bulletin 16, ( ) for one or more of the following materials.

I. Coarse Aggregate: Type A( ), Type A, Bituminous Only ( ), C ( ), Stone ( ), Gravel), or Slag ( ), Recent ( ), or Reclaimed ( ), Blast Furnace), Open Hearth ( ), Basic Oxygen ( ) Granulated ( )

2. Fine Aggregate: Type A ( ), B-Bituminous Only ( ), White ( ) Natural-Bank ( ), Pit ( ) River ( ) or Manufactured Sand from Conglomeratic Sandstone) Limestone ( ) Other ______

3. Anti-Skid: AS 1 ( ), AS 2 ( ), AS 3 ( ), 4 ( )

4. Mineral Filler ( )

B. uality Control: Producers records indicate that samples are tested at the rate of about one samples per week or one sample per 500 ton(s).
These tests are made at this location ( ) or at ______
by employees of Y Aggregates

At this location, the following equipment is available for quality control testing:
None ( ), Mechanical shaker with timer for coarse aggregate ( ), For fine aggregate ( ), For Anti-Skid ( ), Standard sieves for coarse aggregate: 4 ( ), 3 ( ), 2 ( ), 2 ( ), 1 ( ), 1 ( ), 3/4 ( ), 1/2 ( ), 3/8 ( ), #4 ( ), #8 ( ), #16 ( ), #100 ( ), #200. For fine aggregate: 3/8 ( ), #4 ( ), #8 ( ), #16 ( ), #30.( ), #50 ( ), #100 ( ), #200 ( ). For Anti-Skid 1 ( ), ( ), 3/8 ( ), 5/16 ( ), #8 ( ), #100 ( ). Unit Weight container one cubic foot, PTM 609 ( ), Balance, 2kg x 1/10 gram, ( ), Platform scale, 200 lb. x 1/10 lb. ( ), Hot plate, 2 burner ( )

TR-430A (10-73)

Comments on the condition of the testing equipment and quality control records:

____

____

____

____

Excavation: The working face is being advanced in an N ( ), E ( ), S ( ), W ( )________________________ly direction. The excavation is being carried out in such a way that contamination of the material by soil ( ), coal ( ), shale ( ), and or ( ) is a major ( ), minor ( ), no ( ) problem. The method of excavating produces no ( ), few ( ), many ( ) oversize pieces that are reduced by drop ball ( ), blasting ( ), or are wasted ( ). The excavated material is transported to the processing plant by belt ( ), truck ( ), barge ( ). For details on the processing and stockpiling, as well as excavating methods, use extra sheets.

Stockpiling: The aggregate is transported to the stockpiles and placed by truck ( ), belt ( ), clam-bucket ( ), movable stacker ( ). The stockpiles are built by casting and spreading ( ), dumping off a ramppile ( ), layering ( ), other ( ).

Evaluation: Because of the excavating ( ), processing ( ), stockpiling ( ) loading ( ), practices, the aggregate delivered to the job site or plant is expected to contain no ( ), little ( ), borderline ( ), excessive ( ), quantities of rock dust ( ), clay ( ), or other deleterious material such as ____
Particle shape is considered to be satisfactory ( ), unsatisfactory ( ), borderline ( ).

Samples for Requalification Submitted on 02/22/2020 .

If aggregate samples are within Specifications, source should be approved Yes No ( ).

( ) PennDER Interim or Final Permit Number 220019003 Additional

Comments: Approved for Rock

____

____

____

____

Reported by ohn Inspector /s/ Title TCIS Date 06/07/2021

MATERIAL PLANT BOOK TABLE OF CONTENTS

PLEASE TYPE OR PRINT IN BLUE OR BLACK INK ALL INFORMATION

pennsylvania
DEPARTMENT OF TRANSPORTATION
www.dot.state.pa.us

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CS-4211B	PROJECT SUMMARY	X	X	X
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CS-4211H	GRADATION OF HOT-BINS AGGREGATE BLEND		X	
CS-4211I	#57 AGGREGATE GRADATION	X	X	X
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CS-4211A (2-12)

MATERIAL TEST RESULTS - AGGREGATE

PLEASE TYPE OR PRINT IN BLUE OR BLACK INK ALL INFORMATION

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DATE															
SIEVE	BAND	MASS(WGT)	%PASS	MASS(WGT)	%PASS	MASS(WGT)	%PASS	MASS(WGT)	%PASS	MASS(WGT)	%PASS	MASS(WGT)	%PASS	MASS(WGT)	%PASS
ORIGINAL MASS															
% MASS LOST															
TESTED BY															
REMARKS															

CS-4211B (2-12)

PROJECT SUMMARY

PLEASE TYPE OR PRINT IN BLUE OR BLACK INK ALL INFORMATION

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SR ______________________ SECTION ______________________ CMS ______________________

CONTRACTOR ______________________________________ SUPPLIER CODE ______________________

DATE	MATERIAL	DESIGN	TOTAL SHIPPED		DATE	MATERIAL	DESIGN	TOTAL SHIPPED	
			TODAY	TO DATE				TODAY	TO DATE

CS-4211C (2-12)

SCALE CHECK PTM 410

PLEASE TYPE OR PRINT IN BLUE OR BLACK INK ALL INFORMATION

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SUPPLIER____

SUPPLIER CODE____

NOMINAL SCALE WGTS/MASSES A ____________________ B ____________________ C ____________________

DATE	TYPE	PERCENT INCRM.	MATL. MASS (WGT)	TEST MASS (WGT)	TRUE MASS (WGT)	SCALE READING	+/- ERROR	PERCENT ERROR	SIGNATURE

SCALE TYPE: A = AGGREGATE B=BITUMEN/ASPHALT C=CEMENT

CS-4211D (2-12)

PLANT SUMMARY - TOTAL COMBINED DAILY SHIPMENTS

PLEASE TYPE OR PRINT IN BLUE OR BLACK INK ALL INFORMATION

pennsylvania
DEPARTMENT OF TRANSPORTATION
www.dot.state.pa.us

SUPPLIER________________________________ SUPPLIER CODE ________________________________

DATE	TODAY	TO DATE	DATE	TODAY	TO DATE	DATE	TODAY	TO DATE

CS-4211E (5-20)

pennsylvania
DEPARTMENT OF TRANSPORTATION
www.penndot.gov

LTS SAMPLE SUBMISSION RECORD

PLEASE TYPE OR PRINT IN BLUE OR BLACK INK ALL INFORMATION

DATE SAMPLED	TR447 NUMBER	MATERIAL TYPE	LOT NO.	SAMPLE CLASS	LAB NO.	RESULTS RECEIVED	PASS/FAIL	REMARKS

CS-4211I (2-12)

MATERIAL TEST RESULTS AGGREGATE NO. 57

PLEASE TYPE OR PRINT IN BLUE OR BLACK INK ALL INFORMATION

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DATE											
SIEVE	**BAND**	MASS (WGT)	**% PASSING**	MASS (WGT)	**% PASSING**	MASS (WGT)	**% PASSING**	MASS (WGT)	**% PASSING**	MASS (WGT)	**% PASSING**
37.5mm (1 1/2”)	**100**										
25.0mm (1”)	**95-100**										
12.5mm (1/2”)	**25-60**										
4.75mm (#4)	**0-10**										
2.36mm (#16)	**0-5**										
U.C.											
WASH											
CRUSH											
ORIGINAL MASS (WGT.)											
% MASS (WGT.) LOSS											
TESTED BY											
REMARKS											

NOTE: MTD RECOMMENDED BREAKER SIEVES, 19mm (3/4”) OR 16mm (5/8”) AND 9.5mm (3/8”)

CS-4211J (2-12)

MATERIAL TEST RESULTS AGGREGATE NO. 8

PLEASE TYPE OR PRINT IN BLUE OR BLACK INK ALL INFORMATION

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DATE											
SIEVE	BAND	MASS (WGT)	% PASSING	MASS (WGT)	% PASSING	MASS (WGT)	% PASSING	MASS (WGT)	% PASSING	MASS (WGT)	% PASSING
12.5mm (1/2")	100										
9.5mm (3/8")	85-100										
4.75mm (#4)	10-30										
2.36mm (#8)	0-10										
1.18mm (#16)	0-5										
WASH											
CRUSH											
ORIGINAL MASS (WGT.)											
% MASS (WGT.) LOSS											
TESTED BY											
REMARKS											

NOTE: MTD RECOMMENDED BREAKER SIEVES, 6.5mm (1/4")

CS-4211K (2-12)

MATERIAL TEST RESULTS FINE AGGREGATE

PLEASE TYPE OR PRINT IN BLUE OR BLACK INK ALL INFORMATION

pennsylvania
DEPARTMENT OF TRANSPORTATION
www.dot.state.pa.us

DATE											
SIEVE	BAND	MASS (WGT)	PERCENT	MASS (WGT)	PERCENT	MASS (WGT)	PERCENT	MASS (WGT)	PERCENT	MASS (WGT)	PERCENT
9.5mm (3/8)											
4.75mm (#4)											
2.36mm (#8)											
1.18mm (#16)											
600µm (#30)											
300µm (#50)											
150µm (#100)											
75µm (#200)											
Fineness Modulus											
WASH											
TESTED BY											
REMARKS											

DATE											
SIEVE	BAND	MASS (WGT)	PERCENT	MASS (WGT)	PERCENT	MASS (WGT)	PERCENT	MASS (WGT)	PERCENT	MASS (WGT)	PERCENT
9.5mm (3/8)											
4.75mm (#4)											
2.36mm (#8)											
1.18mm (#16)											
600µm (#30)											
300µm (#50)											
150µm (#100)											
75µm (#200)											
Fineness Modulus											
WASH											
TESTED BY											
REMARKS											

CS-4211L (2-12)

MATERIAL TEST RESULTS AGGREGATE NO. OGS

PLEASE TYPE OR PRINT IN BLUE OR BLACK INK ALL INFORMATION

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DATE											
SIEVE	**BAND**	MASS (WGT)	**% PASSING**	MASS (WGT)	**% PASSING**	MASS (WGT)	**% PASSING**	MASS (WGT)	**% PASSING**	MASS (WGT)	**% PASSING**
50mm (2")	**100**										
19.0mm (3/4")	**52-100**										
9.5mm (3/8")	**36-65**										
4.75mm (#4)	**8-40**										
1.18mm (#16)	**0-12**										
U.C.*											
WASH	**75% (3 face)**										
CRUSH	**0-5**										
ORIGINAL MASS (WGT.)											
% MASS (WGT.) LOSS											
TESTED BY											
REMARKS											

NOTE: MTD RECOMMENDED BREAKER SIEVES, 37.5mm (1 1/2") AND 12.5mm (1/2")

* The required minimum coefficient of uniformity for individual samples is 3.5. Provide No. OGS material that has a minimum average coeffieient of uniformity of 4.0.

CS-4211M (2-12)

MATERIAL TEST RESULTS AGGREGATE NO. 67

PLEASE TYPE OR PRINT IN BLUE OR BLACK INK ALL INFORMATION

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DATE											
SIEVE	BAND	MASS (WGT)	% PASSING	MASS (WGT)	% PASSING	MASS (WGT)	% PASSING	MASS (WGT)	% PASSING	MASS (WGT)	% PASSING
50.mm (2")	200										
19.0mm (3/4")	90-100										
9.5mm (3/8")	20-55										
4.75mm (#4)	0-10										
2.36mm (#8)	0-5										
WASH											
CRUSH											
ORIGINAL MASS (WGT.)											
% MASS (WGT.) LOSS											
TESTED BY											
REMARKS											

NOTE: MTD RECOMMENDED BREAKER SIEVES, 37.5mm (1 1/2") AND 12.5mm (1/2")

CS-4211N (2-12)

MATERIAL TEST RESULTS AGGREGATE NO. 2A

PLEASE TYPE OR PRINT IN BLUE OR BLACK INK ALL INFORMATION

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DATE											
SIEVE	**BAND**	MASS (WGT)	**% PASSING**	MASS (WGT)	**% PASSING**	MASS (WGT)	**% PASSING**	MASS (WGT)	**% PASSING**	MASS (WGT)	**% PASSING**
50mm (2”)	**100**										
19.0mm (3/4”)	**52-100**										
9.5mm (3/8”)	**36-70**										
4.75mm (#4)	**24-50**										
1.18mm (#16)	**10-30**										
75µm (#200)	**DRY**										
WASH	0-10										
CRUSH	(A) 55-100 (C) 50-100										
ORIGINAL MASS (WGT.)											
% MASS (WGT.) LOSS											
TESTED BY											
REMARKS											

NOTE: MTD RECOMMENDED BREAKER SIEVES, 37.5mm (1 1/2”) AND 12.5mm (1/2”)

NOTE: DRY 75µm (#200) SIEVE FOR INFORMATION ONLY. (NOT REQUIRED SPEC. SIEVE)

CS-4221A (2-12)

MOISTURE TESTS

PLEASE TYPE OR PRINT IN BLUE OR BLACK INK ALL INFORMATION

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FINE AGGREGATE ABS. ________________

SUPPLIER CODE ______________________

DATE	TIME	WET MASS(WGT)	DRY MASS(WGT)	DIFF.	% MOIST

COARSE AGGREGATE ABS. ______________________________

SUPPLIER CODE ______________________________

DATE	TIME	WET MASS(WGT)	DRY MASS(WGT)	DIFF.	% MOIST

CS-4221C (2-12)

RECORD OF DAILY ORDERS AND RELEASES

PLEASE TYPE OR PRINT IN BLUE OR BLACK INK ALL INFORMATION

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CONTRACTOR______________________________ SUPPLIER______________________________

SUB-CONTRACTOR ________________________ SUPPLIER CODE ______________________________

DATE OF REQUEST	TIME OF REQUEST	DATE TO BE SHIPPED	SR	SEC.	QTY	MATL. TYPE	RELEASED BY	DATE RELEASED	TIME RELEASED	REMARKS
										130

CS-4221E (2-12)

EQUIPMENT CALIBRATION RECORD

PLEASE TYPE OR PRINT IN BLUE OR BLACK INK ALL INFORMATION

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DATE	AIR METER SERIAL #	MOISTURE METER	WATER METER	ADMIXTURE DISPENSER	FLUID-O METER	UNIT WT BUCKET	LAB. SCALES	THERMO METER	MISC.	CALIBRATED BY

CS-4221G (2-12)

ANTI SKID SUMMARY AND MOISTURE RECORD

PLEASE TYPE OR PRINT IN BLUE OR BLACK INK ALL INFORMATION

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SUPPLIER ______________________________ SUPPLIER CODE ____________________

TYPE ____________________

			TEST NO. 1				TEST NO. 2								
DATE	PURCHASE ORDER	ITEM NO.	WET WGT(MASS)	DRY WGT(MASS)	DIFF	%	WET WGT(MASS)	DRY WGT(MASS)	DIFF	%	% AVG	WET T/mt.	DRY T/mt.	TOTAL DRY T/mt.	TESTER

TR-4126A

AGGREGATE REPORT

☐ FINE AGG. ☑ COARSE AGG. ☐ ANTI SKID	☐ ACCEPTANCE ☐ VERIFICATION ☐ INFORMATION	☐ CONSTRUCTION ☐ MAINTENANCE	P.O./CONT. NO
MAT'L SPEC TYPE ______	DATE SAMPLED ______	ITEM NUMBER	ITEM QUANTITY

PRODUCER/LOCATION ____________________

LOT NO. ______

TON(NES) ____ TO ______

SYS	SR/PO	SPUR	PHA	SEC	ORG	CO

☐ GRAVEL ☐ SAND
☐ SLAG ☐ COKE
☐ STONE ☐ CINDERS

TON(NES) SHIPPED:
TODAY ______
TO DATE ______
BALANCE ______

SUBLOT NO.	1		2		3		SPEC. LIMITS		STATISTICAL ANALYSIS		
TON(NE) SAMPLED											
SIEVE	MASS (WT)	%	MASS (WT)	%	MASS (WT)	%	L	U	X	S	PWL
100 mm (4")											
90 mm (3 1/2")											
75 mm (3")											
63 mm (2 1/2")											
50 mm (2")											
37.5 mm (1 1/2")											
31.5 mm (1 1/4")											
25.0 mm (1")											
19.0 mm (3/4")											
12.5 mm (1/2")											
9.5 mm (3/8")											
8.0 mm (5/16")											
4.75 mm (#4)											
2.36 mm (#8)											
1.18 mm (#16)											
600 µm (#30)											
425 µm (#40)											
300 µm (#50)											
150 µm (#100)											
75 µm (#200)											
INITIAL DRY MASS (WT)											

MATERIAL TYPE:

TESTED BY:

DEPT. INSPECT.

WITNESSED BY:

SOURCE TECH.

REVIEWED BY:

COUNTY MGR.

D.M. UNIT

DIST. ENGR.

PWL ______

PAY ______ %

WET MASS(WT)-DRY MASS(WT)
DRY MASS (WT)
X100 = % MOISTURE

MAT'L FINER THAN 75µm (# 200)(FINAL WGT)											
CRUSHED FRAG MASS (WT) % (FINAL WGT)											
UNIT WEIGHT KG/M³ (LBS/CF)											
COEFFICIENT OF UNIFORMITY											
WEIGHT USED FOR FINE GRADATION											
FACTOR											

#200 Wash Start Wgt.			
Crush Cnt. Start Wgt.			

REMARKS

AVERAGE = $X = \frac{\sum_{i=1}^{n} X_i}{n}$

STANDARD DEVIATION = $S = \sqrt{\frac{\sum_{i=1}^{n} (X_i - X)^2}{n-1}}$

$Q_u = \frac{(U - X)}{S}$ $Q_L = \frac{(X - L)}{S}$

PWL=$(P_U+P_L) - 100$

TR-4254 (9-72)

PENNDOT

STRAIGHT LINE ANALYSIS CHART

District ____________
County ____________
Route ____________
Date ______ to ______

Section__________________________Project No.____________________Contractor ____________________________

Inspector

Project Engineer

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certificate of compliance

inStrUctionS

form cS-4171 is to be completed by the party that is shipping approved material to the next destination.

refer to publication 2, project office manual, Section B.6.3 for additional guidance in completing this form.

1. **coUntY, Ir/Sr, Sec/SeG, ecmS#**
   Provide the project information where the material is being shipped. If information is unknown, leave blank. It will be completed by the Project Contractor.

2. **name of manUfactUrer, faBricator, coater, precaSter or proDUcer**
   - Check appropriate box: manufactured, fabricated, coated, precasted or produced as appropriate. If a single company performs more than one operation (e.g., a company manufactures and coats guiderail), more than one box may be checked.
   - Also, provide the name and the supplier code of the manufacturer, fabricator, coater or precaster of the material listed in Bulletin #15 or the name and the supplier code of the Producer of material listed in Bulletin # 14, 41 or 42.

3. **meetS Specification reQUirementS**
   List the specification under which the product is approved.

4. **SHippeD to**
   List the name of the company to which the material is being shipped.

5. **lot nUmBer, QUantitY, DeScription of material**
   List the unique Lot Number for the product, the quantity being shipped to the project or next destination, and a description of the approved material as listed in PennDOT Bulletin # 15, 14, 41, or 42.

6. **cHecK tHiS BlocK if YoUr proDUct containS iron or Steel**
   - Check box if your product contains iron or steel, and complete the additional check boxes. If your product does not contain iron or steel, skip to Item# 7.
   - Check one of the two boxes to indicate whether the product is composed of 100% US steel or whether it contains the minimum allowed foreign steel.
   - Check one of the three boxes to indicate whether your product is identifiable steel, unidentified steel, or receives in-plant inspection by the Department or Department Representative.
   - Be sure to provide the required supporting documentation.

7. **VenDor claSSification (cHecK one BlocK onlY)**
   If you are a Manufacturer, Fabricator, Coater or Precaster listed in Bulletin #15, or a Producer listed in Bulletin # 14, 41 or 42, check block # 1.

   If you are a *Distributor, *Supplier or *Private Label Company of Bulletin #15 items, check block # 2.
   (* - These categories are not eligible for listing in Bulletin #15, however, you may provide material for PennDOT projects on condition that the material being shipped is listed in Bulletin #15.)

8. **certification reQUirementS, name, title, company name, Signature, and Date**
   Enter the required information and sign the Certificate of Compliance form. Ink signatures or electronic signatures are acceptable.

9. **complete line # 9 onlY if YoU cHecKeD BlocK # 2 on line # 7, otHerWiSe leaVe BlanK**
   List company that sold the material to you. (Company Name)

<u>in aDDition:</u>

2. & 5. Private Label Companies who complete the Certificate of Compliance form CS-4171 must identify the true manufacturer (Line 2) and the approved material (Line 5) as it is listed in Bulletin # 15 under that manufacturers listing.

After completing the Certificate of Compliance form CS-4171, maintain the original at your company's location. A copy of the Certificate of Compliance form must accompany your material shipment to its next destination. Also, if you receive material shipments from other companies related to PennDOT projects, the accompanying Certificate of Compliance forms must be kept on file at your location. These files must be available for inspection and verification by a Department Representative for a period of not less than THREE years from the date of the last shipment.

CS-4171 (3-19)

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certificate of compliance

1. **ucoUntY:**____________________ **ulr/Sr:**____________ **uSec/SeG:**___________ **uecmS#:**___________

(**u** - To be completed by the party that will ship the material to the project, otherwise leave blank.)

2. I / WE hereby certify that the material listed on line 5 was:

If a single company performs more than one operation (e.g., a company manufactures and coats guiderail), more than one box may be checked.

☐ Manufactured ☐ Fabricated ☐ Coated ☐ Precasted ☐ Produced

By____ ____________________________

(Name of Manufacturer, Fabricator, Coater, Precaster or Producer) (Supplier Code)

3. and the party listed above certifies that the material(s) on line 5 meets the requirements of

publication 408, Section(s) ____

aaSHto, aStm, Federal or other designation ____________________________________

4. The material listed below is being shipped to: ____________________________________

(Company Name)

5.

lot no.	**QUantitY**	**approVeD material aS liSteD in pennDot BUlletin**

6. ☐ **cHecK Here if YoUr proDUct containS iron or Steel.** I certify the material identified above conforms to Sections 106.01 and 106.10(a) of Publication 408.

cHecK one of tHe tWo BoXeS:

☐ Product is 100% US steel.

☐ Product contains minimal foreign steel in accordance with Act 3 and Buy America. **attach form cS-4171S with receipts or invoices.**

cHecK tHe BoX tHat applieS to YoUr proDUct:

☐ 'Identifiable Steel' - Steel products that contain permanent markings that identify that the material was melted and manufactured in the United States. **only form cS-4171 is required.**

☐ Steel Products and Products Containing Steel with In-Plant Inspection by the Department or a Department Representative - **for 100% US steel products where in-plant inspection has verified that the steel was melted and manufactured in the United States, only form cS-4171 is required. for products where in-plant inspection has verified minimal foreign steel in accordance with act 3 and Buy america, attach bills of lading or shipping documents for foreign steel, and attach form cS-4171S with supporting documentation.**

☐ 'Unidentified Steel' – Steel products that do not meet the definition of ''Identifiable Steel' and do not receive in-plant inspection as defined above. **for 100% US steel products, attach supporting documentation including invoices, bills of lading and mill test reports that positively identify that the steel was melted and manufactured in the United States. for products containing minimal foreign steel in accordance with act 3 and Buy america, attach bills of lading or shipping documents for foreign steel, and attach form cS-4171S with supporting documentation.**

7. **VenDor claSSification (cHecK one BlocK onlY) -**

☐ **#1 manufacturer, fabricator, coater, precaster listed in Bulletin # 15, or producer listed in Bulletin # 14, 41 or 42**

I certify that the above statements are true and to the best of my knowledge, fairly and accurately describe the product(s) listed.

☐ #2 **Distributor, Supplier or *<u>private label company</u> not listed in Bulletin # 15. also, complete line 9**

I certify that the material being supplied is one and the same as provided to us by the manufacturer listed on this document and quantities listed above are accurate.

8. **name (print) :**____________________________ **title:** ____________________

companY name : ____

SiGnatUre : ______________________________ **Date:** __________________

By Responsible Company Offical

9. List company that sold you the material(s) documented above: ____________________________

(Complete if you checked Block # 2 on line # 7, otherwise leave blank.) *(Company Name)*

Quality Control Plan and Acceptance of Aggregates

A. Quality Control Plan:

The essence of an aggregate technician's job is ensuring and documenting the specification compliance of the materials to be used. This is the world of Quality Control and Quality Assurance, commonly referred to as QC/QA. The total concept of QC/QA has many manifestations. Generally, Quality Control is what the producer does to assure compliance. Quality Assurance is what others do to make sure that the quality control plan has been followed.

The activities of Quality Control are spelled out in the Plant's approved Quality Control Plan. The critical guidance document is PennDOT Publication 2, Project Office Manual. In the manual under Part B, Section 7, the subjects of "Minimum Records and Documentation (pages 15-1,2) and "Minimum District Quality Assurance Plan Aggregate Sources" (pages 16-1, 2, 3, 4, 5, 6) are discussed.

Once a Quality Control Plan has been submitted and approved, the quarry may proceed with aggregate production. The guidelines for this section are the Quality Control Plan discussed above. The entire part of the Publication 408 dealing with aggregates, which is Section 703, is provided in this manual. The actual procedures for recording data and recommended actions for certain data patterns are found in PennDOT Publication 25 – Quality Assurance Manual, in which aggregates are specifically discussed.

B. <u>Verification and Quality Assurance Samples:</u>

Type of Sample	Frequency/Quantity	Tested at any by Whom
1. Quality Control Plan	Minimum 1/day for first 500T; extra 1/day for each additional 1,000T	At source by Aggregate Tech.
2. District / Source Verification	Minimum 1/month if shipping < 10,000T per month >10,000Tper month 1 for each 30 days of shipping to the Department	At source by inspector.
3. Project Verification: collected at point of placement	1 sample for > 1,000T<2,000T 2 samples for > 2,000T<10,000T 3 samples for > 10,000T < 25,000T 1 sample for each additional 25,000T	At source or field lab by Department Inspector
4. Quality Assurance / Independent Assurance	Minimum once every 5 years or when source is shipping at least 50,000 SY Subbase or 5,000 CY of structure backfill to a Federally Fund Project on the NHS	Laboratory Testing Section (LTS) Harrisburg

SUB ECT

MINIMUM DISTRICT QUALITY ASSURANCE PLAN - AGGREGATE SOURCES

1. The District Materials Engineer/Manager (DME/DMM) or a member of DME/DMM staff will visit each source shipping for Department use at least once a year. Also, the District will conduct one visit per month to each source shipping a minimum of **10,000 tons** per size of aggregate for Department use.

2. A visit will include District verification sampling and testing and a detailed review of the quarry s quality control activities utilizing a District uality Assurance (D A) check-off list. All findings and corrective actions will be documented in the Plant Master Diary and a copy of the check-off list will be filed with plant records.

   For sources shipping less than 10,000 tons each month, perform a minimum of one visit for each 30 days of shipping for Department use. These visits will include a detailed review of the quarry s quality control activities utilizing a D A check-off list. All findings and corrective actions will be documented in the Plant Master Diary and a copy of the check-off list will be filed with plant records.

   Assure that the District Verification sample test results are entered on the straight-line analysis charts for comparison purposes to the most recent production test results.

3. District Verification Sampling and Testing.

   The District Representative will:

   a. Direct the supplier to obtain a sample (n=3) from the stockpiles designated for Department use. Assure that each sample from the stockpile is obtained according to AASHTO R 90 or from mini stockpiles. When the mini-stockpile method is chosen, the following procedure will be used:

      - The District Representative will assure that the loader operator places approximately 10 tons of aggregate into a mini-stockpile on a suitable surface, and uses the loader bucket to strike off the top of the mini-stockpile.

      - The District Representative will assure that the supplier obtains sufficient material from random locations on the mini-stockpile using a square faced shovel to do the necessary sampling.

b. Assure that all required tests are performed on equipment provided for Department use as specified in Publication 408, Sections 703.1(b) and 703.2(b), Publication 408. Evaluate material not meeting specifications as specified in Publication 408, Section 106.03(a)3to determine the percent within limits (PWL) for each sieve that does not meet the specifications, including the 75 m (No. 200) sieve. Average the results of all sieve analysis tests and, when applicable, the crush count and wash test to determine the PWL. If results show less than 90% PWL, direct the supplier to immediately cease all shipments from that stockpile. Direct the supplier to build a new stockpile for that type of material for Department use.

Notify the supplier immediately to increase the quality control testing and to construct a minimum stockpile of 300 to 500 tons or the quantity remaining on the order. Do not permit shipments by certification from this stockpile until a Department representative evaluates all test data and verifies the test results.

4. Records Review:

The District Representative will:

a. Assure that all quality control test results comply with approved C Plan frequencies.
b. Review straight-line charts and document any noted trends and whether appropriate action was taken.
c. Compare the results of all previous Central Office uality Assurance samples from LTS to the results of the companion samples performed by the technician for uniformity and document all comments.
d. Assure that the technician s plant documentation system and plant delivery tickets comply with POM Section B.7.15.

DISTRICT QUALITY ASSURANCE
AGGREGATE SOURCE INSPECTION CHECK-OFF LIST

PRODUCER ________________ LOCATION _____

BULLETIN 14 CODE _________ REPORT # _____

DATE OF REVIEW____________ DATE OF LAST REVIEW _

Y	N	N/A	
( )	( )	( )	1. Is the current Form TR-430A on file at the source
( )	( )	( )	2. Do Inspectors/Laboratory facilities meet Publication 408 requirements
( )	( )	( )	3. Do Laboratory scales and balances have annual calibration stickers attached Calibration Date: _________
( )	( )	( )	4. Is all required lab equipment on hand and working properly
( )	( )	( )	5. Does the plant technician have required PTMs, ASTM, or AASHTO Standards available for review and use
( )	( )	( )	6. Is the Technician certified Technician s Name:______________________ NECEPT #________ Exp. Date: ___________
( )	( )	( )	7. Is the plant technician performing the tests properly
( )	( )	( )	8. Is the technician able to perform their technical duties without outside interference
( )	( )	( )	9. Is a current copy of the approved uality Control Plan on file
( )	( )	( )	10. Is uality Control Plan being followed
( )	( )	( )	11. Are quarrying, dredging, or processing plant operations satisfactory

Y	N	N/A	
( )	( )	( )	12. Are stockpiles intended for Department use identified
( )	( )	( )	13. Are source verification samples lifted according to AASHTO R 90 , or Mini-stockpiles (Check one)
( )	( )	( )	14. If used, was mini-stockpile constructed and sampled properly
( )	( )	( )	15. Are aggregate samples reduced to testing size, according to AASHTO R 76
( )	( )	( )	16. Is Unit Weight, according to AASHTO T 19, tested twice a year or as required
( )	( )	( )	17. Is the Plant Master Diary being kept current
( )	( )	( )	18. Are uality Assurance and District Verification sample results plotted on the straight-line charts
( )	( )	( )	19. Are production samples and field verification samples documented on Form CS-4211 and plotted on the straight-line charts
( )	( )	( )	20. Are production samples selected prior to stockpiling
( )	( )	( )	21. Do straight-line charts have action points established on critical screens
( )	( )	( )	22. Are Form CS-4171 certifications filled out properly
( )	( )	( )	23. Does weighmaster have a valid license Exp. Date: _______________
( )	( )	( )	24. Is licensed public weighmaster signing all delivery tickets or following the electronic signature security procedures in POM B.7.2
( )	( )	( )	25. Do truck scales have a valid annual certification

Y	N	N/A	
( )	( )	( )	26. Were truck scales checked for zero balance, cleanliness, and freedom of action and documented in the Plant Master Diary
( )	( )	( )	27. Are trucks tared by weighmaster once each day, or more when weather conditions warrant
( )	( )	( )	28. Is the mechanical sieve shaker(s) calibrated according to PTM No. 608
( )	( )	( )	29. Do any unsafe conditions exist that warrant corrective action

DEVIATIONS FOUND: ____________________

CORRECTIVE ACTION TAKEN: ____________________

FOLLOW-UP REVIEW RE UIRED: ____ (YES) ___ (NO)

ADDITIONAL COMMENTS: __________

INSPECTION CONDUCTED BY: _______ DATE: ______________

TECHNICIAN S SIGNATURE: ________ DATE: ______________

REVIEWED BY: ______________________ DATE: ______________

Technician s signature is required. Leave a copy of this review at the plant.

SUB ECT

CONSTRUCTION AGGREGATES

Construction aggregates are accepted by the Department by the certification process commonly referred to as certification acceptance . This acceptance is based on uality Control tests conducted by the producer at the quarry and District uality Assurance Source Verification samples (stockpile verification) tested by the Department plant inspector. Refer to Publication 408, Section 703.5(b).

Subbase aggregate placed under roadway and shoulders on the project is subject to additional testing, as is any size of aggregate which is visually suspect for its intended use regardless of the estimated project quantity. No. 2A aggregate used as shoulder backup material, pipe backfill or other uses is not to be included for testing. These additional tests are project verification samples that are taken at the point of placement and tested by the Department representative, if quantities exceed minimum threshold amounts. These samples may be tested at the producer s location or on the project if a soils lab is present. Refer to Publication 408, Section 703.5(b)3, Table F. This table indicates the number of project verification (FV) samples that must be taken for various amounts of each type (gradation) of coarse aggregate. Each sample consists of three increments or three bags (n=3). Publication 408, Section 703.5(b)3, Table F, is based on estimated total project quantities (of each aggregate type) at the beginning of the project. The table is not a progressive table that is advanced through, row by row, as quantities placed on the project accumulate. Sampling points (targets) should be established in the initial stages of the project and posted so that inspectors are aware of their responsibility to capture project verification increments at the proper time and tonnage. The running total of each aggregate will also need to be maintained so the inspector will be able to anticipate when a sampling point is reached. The aggregate should be sampled according to PTM No. 639 or AASHTO R 90.

The increments that compose a sample must be randomly selected, using PTM No. 1 under the direction and supervision of the inspector. Regardless of how the increment locations are calculated, the important point is that the increments that make a sample are unbiased and randomly selected.

Note: Theabbrevia tion FV is used here to ma inta in consistency with the sample cla ssifica tions listed on the reverse side of a Form TR-447 except these samples are not sent to LTS for testing and completing a Form TR-447 is not required.

TYPICAL SAMPLE PROCEDURE

The contractor will furnish the inspector or Project Manager with an estimate of tonnage for each type of aggregate at the beginning of the project. If the project is to use 1000 or more tons of No. 2A aggregate for subbase under the roadway or shoulders, the inspector should select project verification samples. The inspector then refers to Publication 408, Section 703.5(b)3, Table F. The estimated project quantities provided by the contractor (or determined by the inspector) are

compared with the Aggregate uantities column of Table F. Aggregate uantities should be considered as the total quantity of subbase under the roadway or shoulders that will be used throughout an entire project lifespan. The inspector will then determine how many total numbers of samples will be required over the life of the project.
It is recommended but not required that the contractor s person who lifts the field verification samples seek training from a certified aggregate technician. This can help to minimize potential issues and ensure that a proper sample is obtained for testing.

The following examples are presented to clarify several different scenarios, based on different total project quantities that an inspector may encounter. Project verification sample locations must be based on tonnage. Once those tonnage locations are determined however, several methods may be employed to randomly select the increments such as time, tons, square area, or distance as long as the method is unbiased and random.

I. SINGLE SAMPLE PROCEDURE (1000 to 1999 tons)

The contractor informs the inspector or Project Manager that an estimated total amount of 1200 tons of 2A subbase is needed for this project. The first row of Publication 408, Section 703.5(b)3, Table F, indicates a quantity of 1,000 tons to less than 2,000 tons will require one sample consisting of three increments (n=3).

The 1200 tons of subbase can be broken down into three equal sublots of 400 tons each. Divide the total 1200 tons by the number of increments in your sample (n=3) to determine the quantity of each sublot . Next, go back to PTM No. 1 and select the next three random numbers in order. Multiply each of the three x factors from PTM No. 1 by the tonnage of the sublot to determine the sample ton for the individual increments. This method is illustrated in Example A.

<u>EXAMPLE A</u> – Increments by ton

Estimated 2A subbase for project = 1200 tons

CALCULATING THE SUBLOTS

<u>STEP A</u> - Go to TABLE F and determine that for 1200 tons of this aggregate gradation, one (1) sample consisting of three (3) increments is required for a project verification sample.

Divide 1200 tons by three increments to get 400 tons/increment.

1200 tons ÷ 3 increments = 400 tons/increment

CALCULATING THE SAMPLING POINTS

STEP B - To determine the sampling point to lift the first increment, go to PTM No. 1 and select a number randomly. Start with any PTM No. 1 number, for this example select 30. The x factor = 0.63 from Table I. Multiply that number by the increment tonnage to determine the target ton to sample for that increment. At this time, also note the succeeding numbers in sequence, 31 and 32, where the x factor is 0.53 and 0.99 respectively.

Increment No. 1 target ton to sample = Tons in sublot multiplied by the x factor
Increment No. 1 target ton to sample = 400   0.63 = 252^{nd} ton
The sample increment may be selected from any part of the hauling unit that contains the target tonnage, in this case, the hauling unit containing the 252^{nd} ton.
STEP C - The next two numbers in sequence from 30 (31 and 32) in PTM No. 1 are used to calculate the second and third sublot sample points. To determine the subsequent increment locations remember to add the quantities of the previous sublot (s).

STEP D - 400 x 0.53 = 212^{th} ton of sublot No. 2
Add the total tonnage for sublot No. 1 to the target ton for increment No. 2 to determine the sampling point from the total tonnage.
Add 400   212 = 612^{th} ton
The second increment would come from the hauling unit containing the 612^{th} ton.

STEP E - 400 x 0.99 = 396^{th} ton of sublot No. 3
Add the total tonnage of the previous two sublots to the target ton for increment No. 3 to determine the sampling point from the total tonnage.
Add 400   400   396 = 1196^{th} ton
The third increment would come from the hauling unit containing the 1196^{th} ton.

These three increments represent one sample and are to be placed on one Form TR-4126A and tested for compliance.

II. MULTIPLE SAMPLE PROCEDURE (2,000 to less than 10,000 tons)

The contractor on a project informs the inspector or Project Manager that an estimated 2,100 tons of 2A subbase is needed for this project. For a project quantity greater than 2,000 tons but less than 10,000 tons, two samples consisting of three increments each (n=3) are required. Compare the anticipated total project tonnage of each material gradation to Publication 408, Section 703.5(b)3, Table F, to determine the number of samples needed. A multiple sample project is explained in Example B. The following example illustrates the procedure for computing multiple samples based on an estimated project quantity of 2,100 tons.

EXAMPLE B – Increments by ton

Estimated 2A material for project = 2,100 tons. Therefore, according to Table F, two samples are needed.

CALCULATING THE VERIFICATION LOTS AND SUBLOTS

STEP A – First divide the project tonnage by the number of samples needed. The estimated 2,100 ton project total is divided by 2 samples.

2,100 ÷ 2 = 1,050 tons of 2A in each verification lot .
Three increments will be taken from the first verification lot of 1,050 tons delivered to the project. Three more increments will be taken from the second verification lot of 1,050 tons delivered to the project. Sample points for each 1,050 tons delivered will be performed as in Example A. Since three increments come from each 1,050 ton then divide each 1,050 into three equal sublots .
1,050 ÷ 3 = 350 ton in each sublot .

CALCULATING THE SAMPLING POINTS

STEP B - The target ton for the first increment is determined by first going to PTM No. 1 and selecting a number randomly, for example select number 63. The x factor is = 0.66 from Table I.
Increment No. 1 target ton to sample = 350 ton x 0.66 = 231^{st} ton.
Increment No.1 will come from the hauling unit containing the 231^{st} ton.

STEP C – The next five numbers in sequence from 63 (64, 65, 66, 67 and 68) in PTM No. 1 are used to calculate the second and third sublot sample points. To determine the subsequent sampling points, remember to add the quantities from the previous sublot (s).

STEP D - The target ton for the second increment is determined by selecting the next consecutive number from the PTM No. 1 Table which in this case is number 64. The x factor is = 0.89

Increment No. 2 target ton to sample = 350 ton x 0.89 = 312^{th} ton in the 2^{nd} sublot .
Increment No.2 sampling point = 350 312 = 662^{nd} ton.
Increment No. 2 will come from the hauling unit containing the 662^{nd} ton of 2A.

STEP E - The target ton for the third increment is determined by selecting the next consecutive number from the PTM No. 1 Table which is 65. The x factor is = 0.67

350 ton x 0.67 = 235^{th} ton in the third sublot .

The target ton to sample would then be 350 350 235 = 935^{th} ton.

The final increment completing the first verification lot would come from the hauling unit containing the 935^{th} ton.

That completes the sampling points/target tons for the first verification lot of 1,050 out of the estimated 2,100 tons for the project.

The second verification lot will be sampled in the same way. The sublot size remains the same at 350 tons, except that 1,050 (2,100 ÷ 2) will be added to the target ton so that the three random increments fall into the second verification lot .

STEP F - The target ton is determined by selecting the next number from Table I of PTM No. 1 which is 66. The x factor is = 0.02

350 ton x 0.02 = 7^{th} ton in the first sublot of the second verification lot .
1,050 7 = $1,057^{th}$ ton. This is the target ton for the first increment of the second verification lot .

STEP G - The next number in the sequence from Table I of PTM No. 1 is 67. The x factor is = 0.93

350 x 0.93 = 326^{th} ton.
1,050 350 326 = $1,726^{th}$ ton. This is the target for the second of three increments needed for the second verification lot of subbase.

STEP H - Continuing the sequence, the next number is 68. The x factor is = 0.40.
350 x 0.40 = 140^{th} ton.
1,050 350 350 140 = $1,890^{th}$ ton. This is the final increment of the second verification lot .

III. MULTIPLE SAMPLE PROCEDURE (10,000 tons to 25,000 tons)

The contractor informs the inspector or Project Manager that an estimated 19,000 tons of 2A subbase/pipe backfill is needed for a project. For a project quantity equal to or greater than 10,000 tons but less than 25,000 tons three samples (of n=3) are required. Compare the anticipated total project tonnage of each material gradation to Publication 408, Section 703.5(b)3, Table F, to determine the number of samples needed. The following example illustrates the procedure for computing three samples based on an estimated project quantity of 19,000 tons.

CALCULATING THE VERIFICATION LOTS AND SUBLOTS

EXAMPLE C – Increments by ton

Estimated 2A material for project = 19,000 tons. Therefore, according to Table F, three samples are needed.

STEP A - Divide the project tonnage by the number of samples needed. The 19,000 ton project total is divided by 3 samples.
19,000 ÷ 3 = 6,333 tons of 2A material in each verification lot delivered to the project.

Three increments will be taken from the first 6,333 tons delivered to the project. Three more increments will be taken from the second 6,333 tons delivered to the project and another three increments from the last 6,333 tons delivered to the project. Sampling points for each 6,333 tons delivered will be performed as in Example B except additional steps will be added to calculate sampling points for a third verification lot . Since three increments come from each 6,333 ton verification lot then divide each 6,333 into three equal sublots .

6,333 ÷ 3 = 2,111 ton in each sublot .

CALCULATING THE SAMPLING POINTS (First Verification Lot)

STEP B – The target ton is determined by first going to PTM No. 1 and selecting a number randomly, for example select number 23. The x factor is = 0.06 from Table I.

Increment No. 1 target ton to sample = 2,111 ton 0.06 = 127^{th} ton placed on project.
The first increment would come from the hauling unit containing the 127^{th} ton.

STEP C – The next sequence number from PTM No. 1 would be 24. The x factor is = 0.03 from Table I.

Increment No. 2 target ton to sample = 2,111 0.03 = 63^{rd} ton.

Increment No. 2 sampling point = 2,111 63 = $2,174^{th}$ ton.

Increment No. 2 will come from the hauling unit containing the $2,174^{th}$ ton.

STEP D – The next sequence number from PTM No. 1 would be 25. The x factor is = 0.55 from Table I.

Increment No. 3 target ton to sample = 2,111 0.55 = $1,161^{st}$ ton.

Increment No. 3 sampling point = 2,111 2,111 1,161 = 5,383rd ton.

Increment No. 3 will come from the hauling unit containing the 5,383rd ton and is the final increment in the first of three verification lots .

CACULATING THE SAMPLING POINTS (Second Verification Lot)

<u>STEP E</u> – The next sequence number from PTM No. 1 would be 26. The x factor is = 0.64 from Table I.

Increment No. 1 target ton from the second verification lot = 2,111 0.64 = 1,351st ton

Increment No. 1 sampling point from the second verification lot = 6,333 1,351 = 7,684th ton.

Increment No. 1 of the second verification lot will come from the hauling unit containing the 7,684th ton.

<u>STEP F</u> – The next sequence number from PTM No. 1 would be 27. The x factor is = 0.30 from Table I.

Increment No. 2 of the second verification lot = 2,111 0.30 = 633rd ton.
Increment No. 2 sampling point from the second verification lot = 6,333 2,111 633 = 9,077th ton.
Increment No. 2 of the second verification lot would come from the hauling unit containing the 9,077th ton.

<u>STEP G</u> – The next sequence number from PTM No. 1 would be 28. The x factor is = 0.51 from Table I.

Increment No. 3 target ton of the second verification lot = 2,111 0.51 = 1.077th ton.

Increment No. 3 sampling point from the second verification lot = 6,333 2,111 2,111 1,077 = 11,632nd ton.

The third increment No. 3 of the second verification lot would come from the hauling unit containing the 11,632nd ton.

CALCULATING THE SAMPLING POINTS (Third Verification Lot)

<u>STEP H</u> – The next sequence number from PTM No. 1 would be 29. The x factor is = 0.29 from Table I.

Increment No. 1 target ton of the third verification lot = 2,111   0.29 = 612th ton.
Increment No. 1 sampling point from the third verification lot = 6,333   6,333   612 = 13,278th ton.

Increment No. 1 of the third verification lot would come from the hauling unit containing the 13,278th ton.

<u>STEP I</u> – The next sequence number from PTM No. 1 would be 30. The x factor is = 0.63 from Table I.

Increment No. 2 target ton of the third verification lot = 2,111   0.63 = 1,330th ton.

Increment No. 2 sampling point from the third verification lot = 6,333   6,333   2,111   1,330 = 16,107th ton
Increment No. 2 of the third verification lot would come from the hauling unit containing the 16,107th ton.

<u>STEP</u> – The next sequence number from PTM No. 1 would be 31. The x factor is = 0.53 from Table I.

Increment No. 3 target ton of the third verification lot = 2,111   0.53 = 1,119th ton.

Increment No. 3 sampling point from the third verification lot = 6,333   6,333   2,111   2,111   1,119 = 18,007th ton.

Increment No. 3 of the third verification lot would come from the hauling unit containing the 18,007th ton.

IV. MULTIPLE SAMPLE PROCEDURE (Each additional increment of 25,000 tons)

The contractor informs the inspector or Project Manager that an estimated total amount of 91,000 tons of 2A subbase is required for this project. The third row of Publication 408, Section 703.5(b)3, Table F, indicates that for a quantity between 10,000 tons to less than 25,000 tons, three samples (consisting of three increments in each sample) are required. Also, since the estimated quantity is more than 25,000 tons, an additional sample (n=3) for each 25,000-ton increment is required as can be seen in the fourth row of Publication 408, Section 703.5(b)3, Table F. Thefirst three samples will be taken out of the first 25,000 tons delivered as illustrated in Section III Example C. With the first 25,000 tons taken care of, the final step is to compute the number of samples needed for each additional 25,000 tons.

<u>EXAMPLE D</u> – Increments by ton

<u>STEP A</u> - Take the estimated total for the project and subtract 25,000.
91,000 – 25,000 = 66,000 tons remaining for each 25,000 ton verification lot .
(the first 25,000-ton increment)

<u>STEP B</u> - 66,000 – 25,000 = 41,000 tons remaining for the next 25,000 tons (25,001 to 50,000).
(the second 25,000-ton increment)

<u>STEP C</u> - 41,000 – 25,000 = 16,000 tons remaining for the last additional portion of 25,000 tons. (the third 25,000-ton increment)

<u>STEP D</u> - Since there now remains less than 25,000 tons, the last sample will be taken from that portion. In this example a sample (n=3) will be taken from the last 16,000 tons delivered to the project.

<u>STEP E</u> - Continue the PTM sequence used for the first 25,000 tons. For illustrative purposes continue the PTM No. 1 sequence from Section III, the next PTM number would be 32.

The 25,000 ton of subbase may be considered a verification lot and can be broken down into three equal sublots of 8,333 tons each. Each 8,333 tons would have an increment taken. The tonnage to sample would be figured as in Section I, with the exception being that the sublot size used would be 8,333 tons as opposed to 300 tons. Also, the PTM x factor would be 0.99. So, taking this into consideration, the following will be the first of three increments for a sample for the first 25,000 ton increment.

<u>STEP A</u> – Target ton to sample = 8,333 x 0.99 = 8,250 ton into the 25,000-ton increment.

Sampling point = 25,000 ton   8,250 = 33,250th ton delivered to the project

<u>STEP B</u> – Target ton to sample = 8,333 x 0.02 (the PTM x factor for 33) = 167

167   8.333   25,000 = 33,500th ton delivered to the project

<u>STEP C</u> – Target ton to sample = 8,333 x 0.61 (the PTM x factor for 34) = 5,083

Sampling point = 5,083   8,333   8,333   25,000 = 46,749th ton delivered to the project

<u>STEP D</u> – Target ton to sample = 8,333 x 0.76 (0.76 = the x factor for 35) = 6,333

Sampling point = 25,000   25,000   6,333 = 56,333rd ton delivered to the project would be the first increment for the second 25,000th ton increment.

STEP E – Target ton to sample = 8,333 x 0.87 (the x factor for 36) = 7,250

Sampling point = 7,250 8,333 25,000 25,000 = 65,583rd ton delivered to the project and so on and so forth. For the final sample take 16,000 tons and dividing into three sublots = 5,333 tons in each sublot . Compute the sampling points as in the above examples.

GENERAL NOTES

All verification testing will be performed by the inspector. All increments of each sample are to be tested. Increments should be tested immediately upon lifting if a lab is convenient and should not wait for other increments to be lifted before tests are performed. As a minimum, tests are to include PTM No. 616 and PTM No. 100. ASTM D 5821 Standard Test Method for Determining the Percentage of Fractured Particles in Coarse Aggregate would have to be included in the case of gravel aggregate. All test results are to be provided within 5 days of the material sampling.

Completed Form TR-4126As are requisite documentation for payment justification, along with certifications (Form CS-4171), delivery tickets, calculations, etc.

For all sample/increment locations, use the y factor of each PTM No. 1 number to determine the location across the width of the placement of where to lift the sample increment. Multiply the y factor by the width of the placementfor the distance left or right as indicated by PTM No. 1. Take all samples prior to any grading or compaction according to PTM No. 639 or AASHTO R 90.

Remember to select sample locations randomly. Never start each day at the beginning of PTM No. 1. Start at a different location each day or continue picking consecutive numbers from the table.

A sample may be taken at any time questionable or marginal material is observed. If the material appears to be segregated, overly fine, or overly coarse, or deemed to contain excessive deleterious material, immediately obtain a bag of material when such material is observed. The sample can always be discarded if not ultimately tested, but can be difficult to locate after the fact. The Department is not obligated to accept material that is deficient just because of certification acceptance. If such samples reveal that the material being shipped to the project is deficient, the District Materials Engineer/Manager (DME/DMM) can investigate the source and implement corrective action in accordance with the specifications and Bulletin 14 if necessary.

In the event that project quantities change to the extent that a final increment would not be reached to provide at least three increments for the verification lot , adjust the verification lot quantity and re-compute the sampling point so three increments are tested and statistically evaluated. ustify through documentation the reason for adjusting sampling points.

FAILURES

Anytime that a project verification sample (n=3) has a PWL 90, discontinue certification acceptance of the material and begin lot acceptance as specified in Publication 408, Section 703.5(b)3.

For subbase acceptance lots (n=3) where the PWL 90, follow Publication 408, Section 703.5(b)3, and determine the degree of non-conformance (DNC) of the lot. Two examples are shown below to illustrate how to determine the DNC for the lot.

<u>EXAMPLE E</u> – Degree of Non-conformance for a non-gravel source

Step 1 Requires Gradation (no crush count) and PWL computations according to PTM No. 6. A PWL for crush count will be 100, since this is a non-gravel source.

Sieve Size	Spec Limits	Incr 1	Incr 2	Incr 3	Average	Standard Deviation	PWL
2-inch	100	100	100	100	100	0	100
3/4-inch	52-100	99	100	98	99	1.0	100
3/8-inch	36-70	68	66	69	68	1.5	100
No. 4	24-50	48	47	51	49	2.1	64
No. 16	10-30	31	33	32	32	1.0	0
No. 200	0-10.49	12.52	11.03	10.99	11.51	0.872	0
Crushed Fragments	55-100						100

464/7 = 66.3
or **PWL = 66**

Step 2: Since PWL 90, Degree of Non-Conformance calculation will be performed

Sieve Size	Spec Limits	Incr 1	Incr 2	Incr 3	Average	Differences for Non-Conforming Averages (1)	Multiplier factor from tables G & I	Product of difference and multiplier (2)
2-inch	100	100	100	100	100		1	0
3/4-inch	52-100	99	100	98	99		1	0
3/8-inch	36-70	68	66	69	68		1	0
No. 4	24-50	48	47	51	49		1	0
No. 16	10-30	31	33	32	32	2	1.5	3.0
No. 200	0-10.49	12.52	11.03	10.99	11.51	1.02	2.5	2.55
								Total = 5.55

(1) For each sieve where the lot average falls out of spec, the absolute difference between the lot average and spec limit will be calculated.
(2) Each difference on a sieve will be multiplied by the factors in Publication 408, Section 703.5(b)3, Table G.

Add the products in right hand column to provide the total Degree of Non-Conformance for the acceptance lot. Use Publication 408, Section 703.5(b)3, Table H, to determine lot disposition. This example would result in a 7% reduction in the unit price paid for the non-conforming acceptance lot.

<u>EXAMPLE F</u> – Degree of Non-conformance for a gravel source

Step 1 Requires gradation, crushed fragments and PWL computations from PTM No. 6

Sieve Size	Spec Limits	Incr 1	Incr 2	Incr 3	Average	Standard Deviation	PWL
2-inch	100	100	100	100	100	0	100
3/4-inch	52-100	99	100	98	99	1.0	100
3/8-inch	36-70	55	46	52	51	4.6	100
No. 4	24-50	38	37	41	39	2.1	100
No. 16	10-30	20	21	22	21	1.0	100
No. 200	0-10.49	6.45	6.69	5.89	6.34	0.411	100
Crushed Fragments	55-100	42	49	56	49	7.0	23

623/7 = 89.0
or **PWL = 89**

Step 2: Since PWL 90, Degree of Non-Conformance calculation will be performed

Sieve Size	Spec Limits	Incr 1	Incr 2	Incr 3	Averag e	Differences for Non-Conforming Averages (1)	Multiplier factor from tables G & I	Product of difference and multiplier (2)
2-inch	100	100	100	100	100		1	0
3/4-inch	52-100	99	100	98	99		1	0
3/8-inch	36-70	55	46	52	51		1	0
No. 4	24-50	38	37	41	39		1	0
No. 16	10-30	20	21	22	21		1.5	0
No. 200	0-10.49	6.45	6.69	5.89	6.34		2.5	0
Crushed Fragments	55-100	42	49	56	49	6	1.0	6.0
								Total = 6.0

(1) For each parameter (sieve or crushed fragments) where the lot average falls out of spec, the absolute difference between the lot average and spec limit will be calculated.
(2) Each difference on a parameter will be multiplied by the factors in Publication 408, Section 703.5(b)3, Table G.

Add the products in right hand column to provide the total Degree of Non-Conformance for the subbase acceptance lot. Use Publication 408, Section 703.5(b)3, Table H, to determine lot disposition. This example would result in a 7% reduction in the unit price paid for the non-conforming acceptance lot.

SUB ECT

INDEPENDENT ASSURANCE PROCEDURES - AGGREGATE SOURCES

The Bureau of Project Delivery (BOPD), Construction uality Assurance Section (C AS) will administer the Independent Assurance program at aggregate sources supplying Department construction projects. The Independent Assurance program provides an unbiased and independent evaluation of the sampling and testing personnel, the testing equipment, and the sampling and testing procedures used in the Department s aggregate acceptance program. Independent Assurance samples will be tested by the BOPD, and the test results will be compared with companion test results run at the aggregate source to verify that results are within established tolerance limits.

During each construction season, the BOPD, C AS will perform a minimum of ten (10) Aggregate Independent Assurance reviews in each District where practical at aggregate sources shipping material to Department projects. Included among these reviews are aggregate sources shipping material to federal-aid projects on the National Highway System (NHS) meeting the following minimum project quantities:

No. 2A Aggregate Subbase: 1 Review 50,000 yd^2

No. 57 Structure Backfill: 1 Review 5,000 yd^3

Note: The source does not need to be producing or shipping material at the time of the review to satisfy this requirement. Material must be obtained from a Department approved stockpile. Sources shipping material for both items require only 1 review. Sources shipping to multiple projects meeting the above requirements require only one review per construction season.

Aggregate Independent Assurance reviews are not limited to aggregate sources shipping to federal-aid projects on the NHS. Independent Assurance reviews are also not limited to No. 2A or No. 57 aggregate types.

The C AS will determine the sources to be reviewed. Sampling and testing for Independent Assurance will be coordinated with the District Materials Engineer/District Materials Manager (DME/DMM) or their staff to coincide with a scheduled District uality Assurance (D A) review, or at a mutually agreed upon time with the DME/DMM or their staff, such as when the District is at the source to test project verification samples.

The following process will constitute an Independent Assurance review. An Independent Assurance sample (n=1) will be taken from an approved Department stockpile at a source supplying aggregate to a Department project, under the direction and supervision of the DME/DMM or their staff. The Independent Assurance sample will be split according to AASHTO

R 76 to obtain two (2) equivalent samples for testing. In addition, a representative sample will be obtained for an IA Wash Test by the Laboratory Testing Section (LTS).

To obtain the required minimum sample size after splitting, the initial sample for each aggregate type must be as follows:

Aggregate	Sample Size
No. 3	130 lbs.
No. 5	80 lbs.
No. 57	75 lbs.
No. 67	65 lbs.
No. 7	65 lbs.
No. 8	30 lbs.
No. 10	5 lbs.
No. 2A	100 lbs.
No. OGS	100 lbs.

Only one (1) aggregate type is required to be tested per each Independent Assurance review.

Sampling and testing at the source will be performed by certified aggregate technicians.

One sample will be tested by the DME/DMM or their staff at the source and one sample will be tested by the source technician, both using the same equipment. The sample tested by the source technician will then be rebagged and sent for testing to the BOPD, LTS. Samples will be tested for conformance to Publication 408, Section 703, Tables C D, plus the Crushed Fragments Test of Table B, when applicable.

A C AS representative does not need to be present for the entire process of Independent Assurance sampling and testing at the source. Whenever a C AS representative does not witness any portion of the process of Independent Assurance sampling and testing at the source, the test results obtained at the source by the DME/DMM or their staff and the source technician should be forwarded to the appropriate C AS representative in a timely manner.

Arrangements for the transportation of the Independent Assurance sample to LTS will be coordinated by a C AS representative with the DME/DMM or their staff. The C AS representative coordinating the review will complete the Form TR-447 for the LTS sample and identify it as an Independent Assurance sample. The method used to perform the Wash Test (Manual or Automatic Aggregate Washer / Plain Water or Wetting Agent) should be reported in the remarks section of the Form TR-447.

Test results from the source will be compared to the Independent Assurance precision tolerances by C AS immediately upon receipt from the District. Those results will then be compared with the test results obtained by LTS for compliance with the Independent Assurance precision tolerances.

Independent Assurance Precision Tolerances

	Sieve Size	Maximum Difference between Test Results
Gradation	2.36 mm (No. 8) sieve and larger	6 %
	1.18 mm (No. 16) through 150 µm (No. 100) sieves	4 %
	75 µm (No. 200) sieve	2 %
Coarse Aggregate Crush Count	---	12 %

When test results vary from the allowed precision tolerances or problems with sampling and testing personnel or equipment are discovered, C AS will immediately inform the DME/DMM. The District will perform an investigation of the discrepancies and take appropriate corrective action where necessary. The District will inform C AS with the results of their investigation and what corrective actions were taken. Where necessary, a C AS representative will perform a follow-up review of the source to insure all deficiencies have been corrected.

Independent Assurance review results will be maintained by C AS for each District. The BOPD will summarize the Independent Assurance review results at the conclusion of each construction season and submit the results to FHWA in an annual report.

PTM 6
Precent Within Limits
(PWL)

LABORATORY TESTING SECTION

Method of Test for

DETERMINATION OF PERCENT WITHIN LIMITS (PWL) FOR CONSTRUCTION AGGREGATE

1. SCOPE

1.1 For determination of Construction Percent Within Limits (PWL) using Statistical Method as in CAMMS.

2. DEFINITION OF A MA OR/MINOR DEVIATION

2.1 Major Deviation - When a sample PWL is less than 90%.

2.2 Minor Deviation - When a sample PWL is greater than 90%, but less than 100%.

3. GENERAL STATEMENTS ABOUT PWL CALCULATIONS

3.1 If all results on a particular sieve or wash test are within the specification limits, then the construction PWL for that result is 100.

3.2 If one or more results of three are outside the specification range for a particular sieve the statistical PWL on the report is used to calculate the total sample PWL based on construction specifications.

3.3 On specification sieves that have an upper limit of 100, $_U$ is not calculated. $_L$ is the only value calculated and used to represent the PWL for that sieve.

3.4 On specification sieves that have a lower limit of 0, $_L$ is not calculated. $_U$ is the only value calculated and used to represent the PWL for that sieve.

3.5 On specification sieves that have both limits as 100, only use the upper limit and calculate only the upper uality Index to represent the PWL for that sieve.

4. CALCULATIONS

Note: The following calculations are from the #4 sieve on the CAMMS report on page 5.

4.1 The lot ( ) measurements are averaged to find $\overline{X}$.

$$\overline{X} = \sum_{i=1}^{n} \frac{Xi}{n}$$

Where:

$\overline{X}$ = Average or mean value of the number of tests to the nearest whole number

n = Size of the sample in whole number increments

i = The ith value in a series of observations in whole numbers

Example: Calculations for the #4 sieve for 3 test results (See an example of a test report on page 5).

$$\overline{X} = \frac{28+22+33}{3} = \frac{83}{3} = 27.7 = 28$$

4.2 The standard deviation s of the sample increments for each sieve is calculated using whole numbers. The calculated value is to the nearest tenth.

$$s = \sqrt{\frac{\sum_{i=1}^{n} (Xi - \overline{X})^2}{n-1}}$$

Where:

$\overline{X}$ = Average or mean value of the number of tests to the nearest whole number

n = Size of sample in whole number increments

i = The ith value in a series of observations in whole numbers

s = The Standard Deviation of the lot of measurements

Example: With the $\overline{X}$ calculated to be 28, s would be calculated.

$$s = \sqrt{\frac{(28-28)^2+(22-28)^2+(33-28)^2}{3-1}} = \sqrt{\frac{61}{2}} = 5.522 = 5.5$$

4.3 The uality Index ($_U$) is found by subtracting the average ($\overline{X}$) of the measurements from the upper specification limits (U) and dividing the result by s and is expressed to the nearest ten thousandth.

$$Q_U = \frac{(U - \overline{X})}{s}$$

Where:

$\overline{X}$	=	Average or mean value of the number of tests
s	=	The Standard Deviation of the lot of measurements
U	=	Upper Specification Limit
$_U$	=	uality Index of the upper specification limit
P_U	=	Estimate of the percentage of a lot which has values equal to or less than the upper specification limit

Example: With the upper specification limit equal to 50, $_u$ would be calculated.

$$Q_U = \frac{50 - 28}{5.5} = \frac{22}{5.5} = 4.0000 \qquad P_U = 100$$

NOTE - P_U was found in Table A of Publication 408, Section 106 for n=3.

4.4 The uality Index ($_L$) is found by subtracting the lower specification limit (L) from the average ( ) and dividing the result by s . This value is expressed to the nearest ten thousandth.

$$Q_L = \frac{(\overline{X} - L)}{s}$$

Where:

L	=	Lower Specification Limit
$\overline{X}$	=	Average or mean value of the number of tests
s	=	The Standard Deviation of the lot of measurements
$_L$	=	uality Index of the lower specification limit
P_L	=	Estimate of the percentage of a lot which has values equal to or greater than the lower specification limit

Example: With the lower specification equal to 24, $_L$ is calculated.

$$Q_L = \frac{28 - 24}{5.5} = \frac{4}{5.5} = 0.7272 \qquad P_L = 72$$

NOTE: P_L was found in Table A of Publication 408, Section 106 for n=3.

4.5 The percentage of material that will fall within the upper tolerance limit (U) is estimated by entering Table A in Publication 408 Section 106, with $_u$, using the column appropriate to the total number of measurements (n).

4.6 The percentage of material that will fall within the lower tolerance limit (L) is estimated by entering Table A in Publication 408 Section 106 with $_L$, using the column appropriate to the total number of measurements (n).

4.7 In cases where both upper (U) and lower (L) tolerance limits are considered, the percentage of material that will fall within tolerance limits is found by adding the percent (P_U) within the upper tolerance limit (U) to the percent (P_L) within the lower tolerance limit (L) and subtracting 100 from the sum.

Example:

Percent within limits = (P_U P_L) - 100

Percent within limits = (100 72) - 100 = 72

Below is an example of how individual PWL s are calculated to determine the construction aggregate specification PWL on a CAMMS report. (See the CAMMS report on page 5.)

Sieve Size	Statistical PWL on Report	Internal Construction PWL Calculations
2		100
3/4	100	100
3/8	100	100
#4	72	72
#16	30	30
Wash Test	100	100
		502/6
		results=83.5=84

Note - If all the test results on the #4 sieve were within the specification limits, it is possible that the statistical PWL on the report will be below 100%. If all the test results for the #4 sieve are within the specification limits, the construction PWL calculations will be 100%.

4.8 To determine the percentage within tolerance when the calculated uality Index (.I.) value is between two tabular values in Table A, the following procedure is used.

4.8.1 The difference between the tabular .I. values on either side of the calculated .I. value will be determined.

4.8.2 The difference will be divided by 2 and the quotient added to the lower tabular .I. value, resulting in the interpolated .I. value.

4.8.3 If the calculated .I. is equal to or greater than the interpolated value, the higher listed percent within tolerance will be used.

4.8.4 If the calculated .I. is less than the interpolated value, the lower listed percent within tolerance will be used.

Note - When percent loss by wash is required, the ( ) and ($\overline{X}$) calculations are rounded to the nearest hundredth. The standard deviation(s) is rounded to the nearest tenth.

```
 REPORT: CA~LR510                 AGGREGATE                       13:20:59
 FINAL REPORT      Ref#:         Lab#:          Pass/Fail: F    CAMSPROD
---------------------------------------------------------------------------
 Cont #:                         QA Rtug: MAJOR       Cntrctr:
 Pr O #:                         Orgnztn:             Lctn Cd:
 Mtl Ds: AGGRGT,COARSE           Section:             L/C XRf:
 408Y/S: 90 703                  Station:             Prt Tkt:
 Supl #:                         Colcted:             Lot Nbr:
 Plc Cl:                         Receivd:             # Incrm: 3
 Smp By:                         Releasd:             447 XRf:
---------------------------------------------------------------------------
TR-447 Remarks: SUBBASE
---------------------------------------------------------------------------
```

SCREEN	LIMITS		R(L)	-1-	-2-	-3-	AVG	ST DEV	R(S)	PWL
2 1/2n				100	100	100	100	.0	0	
1 1/2"				100	100	100	100	.0	0	
3/4"	52	100	48	88	84	89	87	2.6	5	100
3/8"	36	70	34	49	42	57	49	7.5	15	100
#4	24	50	26	28	22-	33	28	5.5	11	72
#8				15	12	20	16	4.0	8	
#16	10	30	20	9-	8-	11	9-N	1.5	3	30
#30				6	5	6	6	.6	1	
#50				4	4	4	4	.0	0	
#100				3	3	3	3	.0	0	
#200				2	2	2	2	.0	0	

LIMITS	R(L)	-1-	-2-	-3-	AVG	ST DEV	R(S)	PWL
PERCENT LOSS BY WASH								
0	10	6.82	4.94	7.06	6.27	1.2	2.12	100

TOTAL SAMPLE PWL BASED ON CONSTRUCTION SPECIEICATIONS: 84 J

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Percent Within Limits Calculations

SECTION 106—CONTROL OF MATERIAL

106.01 GENERAL Use material complying with the requirements of these specifications. At the pre-construction conference, submit a list of material to be sampled and tested by the Contractor and a list of material to be sampled and tested by the Department.

Comply with the provisions of the Pennsylvania Trade Practices Act, 71 P.S. Section 773.101, et seq., concerning the purchase of aluminum and steel products produced in a foreign country. On Federal-Aid projects, also comply with the provisions specified in Section 106.10.

Comply with the provisions of the Steel Products Procurement Act, 73 P.S. Section 1881, et seq. in the performance of the contract or any subcontract.

Following contract execution, furnish to the Department a complete statement of the project construction material s origin, composition, and manufacture.

For Fabricated Structural Steel materials, as identified in Section 1105.01(a) and inspected in accordance with Section 1105.01(e), and any other fabricated aluminum, precast or prestressed concrete products inspected during manufacturing, stamped and approved for shipment by the Department s Representative, furnish Form CS-4171 to the Inspector-in-Charge. Certified mill test reports for any steel included will be reviewed by the Department s Inspector and retained by the fabricator.

For all other steel products or products containing steel that will be permanently incorporated in the project, provide the Inspector-in-Charge the following when the product is delivered to the project site:

- For any identifiable steel products, certification that Section 4 of the Steel Products Procurement Act, 73 P.S. Section 1884, has been complied with. Identifiable steel products are steel products which contain permanent markings which indicate the material was both melted and manufactured in the United States.
- For all other unidentifiable steel products, documentation such as invoices, bills of lading, and mill certification that positively identify that the steel was melted and manufactured in the United States.

The provisions of the Steel Products Procurement Act will not be waived unless the Secretary has determined, under authority granted in Section 4(b) of the act, that a certain steel product or products is not produced in the United States in sufficient quantities to meet contract requirements. Such a determination will be set forth in a proposal for the Department s review and response. Include with the proposal a comprehensive list of sources, including names and contact information, for verification. The Secretary does not have the authority to waive the provisions specified in Section 106.10.

Steel products are defined as products rolled, formed, shaped, drawn, extruded, forged, cast, fabricated, otherwise similarly processed, or processed by a combination of two or more of these operations from steel made in the United States by the open hearth, basic oxygen, electric furnace, Bessemer, or any other steel-producing process. Included are cast iron products and machinery and equipment as listed in United States Department of Commerce Standard Industrial Classification 25, 35, and 37 and made of, fabricated from, or containing steel components. If a product, as delivered to the project, contains both foreign and United States steel, such product is considered to be a United States steel product only if at least 75% of the cost of the articles, materials, and supplies have been mined, produced, or manufactured, as the case may be, in the United States. On Federal-Aid projects, comply with the provisions specified in Section 106.10.

No payment will be made on the contract if unidentified steel products are supplied, until the hereinbefore requirements are met.

Any payments made that should not have been made may be recoverable from a manufacturer or supplier as well as from a contractor or subcontractor.

Any person who willfully violates the Steel Products Procurement Act will be prohibited from submitting bids for any contract for a period of 5 years from the date of determination that a violation has occurred. If a subcontractor, manufacturer or supplier, violates the Steel Products Procurement Act, such person will be prohibited from performing any work or supplying any materials to the Department for a period of 5 years from the date of determination that a violation has occurred.

If steel products are used as a construction tool or appurtenance and will not serve a permanent functional use in the project, compliance with the Steel Products Procurement Act is not required.

When standard manufactured items are specified and these items are identified by unit mass (unit weight), section dimensions, or similar characteristics, their identification will be considered to be nominal masses (weights) or dimensions. Unless more stringently controlled by specified tolerances, industry established manufacturing tolerances will be accepted.

106.02 MATERIAL

(a) Preliminary Acceptance and Approval. Have each material and material source of supply listed on Form CS-200 (Source of Supply – Materials) or Form CS-201 (Source of Supply – Traffic Control Devices) and approved before delivery to project. Department Bulletin listed material and material sources are available for use by the Contractor. If non-Bulletin material or material sources are proposed for use, the requirements specified in 106.02(a)2 must be met before these materials are delivered to the project. The Department reserves the right to obtain samples of any material provided by the Contractor for laboratory testing to verify compliance with specifications.

1. Bulletin Material, Material Application, and Material Source. Defined as any of the following:

- Any material and material source listed in Bulletin 14 and used in the material application as specified in the Bulletin, Publication 408, or a Special Provision.
- Any material and material source listed in Bulletin 15 and used in the material application as specified in the Bulletin, Publication 408, or a Special Provision.
- Any asphalt material and material application specified in Publication 408 and produced at a source listed in Bulletin 41.
- Any cement concrete material and material application specified in Publication 408 and produced at a source listed in Bulletin 42.

Submit a CS-200 or CS-201 to the Representative with the following information: contract item number, item description, material description/type/class, product name, manufacturer/producer plant location, applicable Bulletin supplier code, Bulletin number, and Publication 408 or Bulletin Section.

If a previously submitted Bulletin material source no longer provides the specified material, submit a change in material to the Representative as outlined on Form CS-200 or CS-201. Once written acceptance is received, furnish material from another Bulletin material source listed in Bulletin 14, 15, 41, or 42.

2. Non-Bulletin Material, Material Application, or Material Source. Defined as any of the following:

- Any material, product, or material source not listed in Bulletin 14 or Bulletin 15.
- Any material, product, or material source listed in Bulletin 14 or Bulletin 15 being used in an application not intended or specified in the Bulletin, Publication 408, or a Special Provision.
- Any asphalt material or product not produced at a source listed in Bulletin 41.
- Any asphalt material or product not specified in Publication 408 or a Special Provision.
- Any ready-mixed, cement concrete material or product not produced at a source listed in Bulletin 42.
- Any ready-mixed, cement concrete material or product not specified in Publication 408 or a Special Provision.

2.a. Construction-Aid Material. A necessary, temporary, or ancillary material that is not specified for use as part of a contract item or extra work item, but used by the Contractor only to aid in the completion of the work. The material is typically not a permanent part of the specified work (example: wood and nails for temporary formwork). The material need not be listed on Form CS-200 and does not require any Department approval for delivery to or use on the project. The Representative reserves the right to determine whether a material is a construction-aid material. Note temporary traffic control items are not construction-aid materials and do need listed on Form CS-201 since these items must be from Bulletin 15 listed sources and are specified for use as part of contract items or extra work items.

2.b. Project-Specific, LTS Approved Material. Non-Bulletin material proposed for use on a particular project as part of a contract item or extra work item, which requires approval by the LTS. Use of material is not meant to circumvent the use of available material sources listed in Bulletin 14, 15, 41, or 42. Have each material and material source listed on Form CS-200 or Form CS-201. The material is defined as any material, product, or material source that meets one or more of the following criteria:

- Meets specified requirements in Publication 408 or Special Provision, for the material and material application.
- Meets specified requirements in AASHTO or ASTM Standard for the material and material application.
- Meets specified requirements in project Special Provision for the material and material application.

Submit material to the LTS for evaluation and testing a minimum of 90 days before planned delivery to the project. Submit the following information to the LTS, with a copy to the Representative: source, description, specified use, C Plan, independent lab test data showing material meets all specified requirements as determined on a single lot of material, and material samples of the kind and quality specified. Do not deliver material to the project until written acceptance is received from the Representative.

2.c. Project-Specific, Locally Approved Material. Non-Bulletin material proposed for use on a particular project as part of a contract item or extra work item, which does not require LTS approval because of the low risk to constructed Project performance, but does require local approval by the Representative (i.e. at the District or project level). This category of material is not meant to circumvent the use of available material sources listed in the Bulletins, or the requirements of Project-Specific, LTS Approved Materials. These materials must meet specification requirements and will be clearly identified in the specification as only needing local approval by the Representative. Have each material and material source listed on Form CS-200 or Form CS-201. Submit for local approval by the Representative all required information for the material, as indicated in the specification.

Examples of locally approved materials are project specific items, such as Section 860 (inlet filter bags), Section 867 (compost filter socks), and Section 868 (compost blanket and compost filter berms) where the specification indicates that these materials are to be locally approved. Bulletin 15 will reference specific Publication 408 Sections that apply to Locally Approved Materials. Bulletin 15 will not list actual materials or material sources for this category of materials as they will be accepted for use on a project-specific basis by local approval.

(b) Inspection. Inspect material delivered to the project and stockpile the material passing inspection for use. Do not incorporate questionable material, until material is tested by LTS and accepted in writing by the Representative. The Department reserves the right to reject questionable material delivered to the project when the LTS test results are not according to the specifications. Furnish assistance to the Inspector, as required to obtain samples.

Allow designated Department representatives to inspect material being used, or intended to be used, at any time before, during, or after material preparation, while being used during the progress of the work, or after the work has been completed. Furnish or arrange with producers or manufacturers to provide necessary material, labor, tools, and equipment for such inspection.

Inspections and tests, if made at any point other than the point of incorporation in the work, will not guarantee acceptance of the material. Inspection and testing performed by the Department will not relieve the Contractor s responsibility for C.

106.03 TESTS AND ACCEPTANCE OF MATERIAL

(a) Restricted Performance Specifications.

1. Responsibility. The Department will be responsible for determining the acceptability of the material and construction. Material will be reviewed for acceptance through the Department s specified acceptance procedures. Sample locations for acceptance testing will be determined by the Department.

Perform sampling and testing for acceptance in the presence of the Inspector, unless otherwise specified. Lot size will be specified. In the event that operational conditions cause work to be interrupted before the specified lot size has been achieved, the lot may be redefined by the Inspector. It is the intent of these specifications that each lot be evaluated based on the same number of samples. Transport acceptance samples from sampling point to testing site or other designated location in the presence of the Inspector.

The Contractor is responsible for the control and quality of the material and construction.

Prepare a C Plan as specified in Section 106.03(a)2.a and submit it to the Inspector-In-Charge for review at the start of the project. Include C sampling and testing frequencies and action points to initiate corrective measures. Notify the Inspector before performing C sampling and testing. Perform C sampling and testing and report results to the Inspector.

Obtain and test samples according to the Department s PTMs. If the required test method is not specified, use methods described in the AASHTO Standard Specifications for Transportation Materials and Methods of Sampling and Testing, and Supplements, Standards and/or Tentatives of ASTM, or other testing procedures adopted by the Department.

Verification sampling and testing will be performed by the District, unless otherwise specified.

A sampling and testing will be performed or witnessed by the BOPD.

Independent Assurance sampling and testing will be administered by the C AS.

2. QC.

2.a Maintain a C system that provides reasonable assurance that materials, products, and completed construction, submitted for acceptance, conform to contract requirements whether self-manufactured, processed, or procured from subcontractors or vendors. When specified, submit for review, a plan of the C system to be used. Have performed or perform the inspections and tests required to substantiate product conformance to contract requirements. Make the inspection and test results available for review throughout the contract life. Procedures will be subject to the review of the Department before the work is started. Charts and records documenting C inspections and tests are the property of the Department. Submit a C Plan for use in compliance with the following guidelines, as a minimum:

2.a.1 Raw Materials. List the source of material along with methods of documentation and testing performed to assure the material quality.

2.a.2 Production Control. List lot size and samples required include sample selection, labeling and test procedure also include manufacturing phase.

2.a.3 Product Testing. List type and frequency of tests to be performed, along with method of documenting and reporting test results. List test equipment and calibration procedure (frequency) required. List procedure for retesting or rejecting items failing the tests. List the disposal methods and location for test samples and rejected lots.

2.a.4 Personnel. List the personnel in charge of C and define their areas of responsibility.

2.a.5 Packaging and Shipping. List method of identifying, storing, loading, transporting, and unloading to assure safe delivery of acceptable material and products.

2.a.6 Documentation. List the procedures used for documentation and certification.

The C Plan and process are subject to periodic review and inspection by the Department.

2.b Promptly record conforming and non-conforming inspection and test results on acceptable forms or charts. Keep these records complete and keep them available for inspection at all times during the performance of the work.

2.c Promptly correct any errors, equipment malfunctions, process changes, or other assignable causes which have resulted or could result in the submission of material, products, and completed construction not conforming to specification requirements.

2.d When required, provide or have provided and maintain measuring and testing devices necessary to ensure that material and products conform to contract requirements. In order to ensure continued accuracy, calibrate these devices at established intervals against Department standards.

2.e When required, make the measuring and testing equipment available to the Representative for use in determining conformance of material, products, or completed construction with contract requirements. In addition, make personnel available for the operation of such devices and for verification of the accuracy and condition of the devices. Have calibration results available at all times. The Department reserves the right to conduct periodic inspections of the measuring and testing devices to confirm both calibration and condition of operation.

2.f Failure to comply with the C Plan may result in suspension of approval to provide material for Department use and/or removal from the approved list of material suppliers in the applicable bulletins.

3. Acceptance Plans.

3.a Percent Within Limits. The percentage of each lot within the specified limits will be determined by the following procedures:

3.a.1 The n sampling positions on the lot will be located by use of the table of random numbers found in PTM No. 1.

3.a.2 A measurement will be made at each location, or a test portion taken and the measurement made on the test portion.

3.a.3 The lot ( ) measurements are averaged to find $\overline{}$.

$$\overline{} = \sum_{i=1}^{n} \frac{{}_i}{n}$$

3.a.4 The Standard Deviation, s, of the lot measurements will be determined as follows:

$$s = \sqrt{\sum_{i=1}^{n} \frac{({}_i - \overline{})^2}{n-1}}$$

3.a.5 The uality Index ($_U$) is found by subtracting the average ( ) of the measurements from the upper specification limit (U) and dividing the result by s.

$${}_u = \frac{(u - \overline{})}{s}$$

3.a.6 The uality Index ($_L$) is found by subtracting the lower specification limit (L) from the average and dividing the result by s.

$${}_L = \frac{(\overline{} - L)}{s}$$

3.a.7 The percentage of material that will fall within the upper limit (U) is estimated by entering Table A or Table B with $_U$, using the column appropriate to the total number of measurements (n). Use Table A if $_U$ has a negative value, or use Table B if $_U$ has a positive value.

3.a.8 The percentage of material that will fall within the lower limit (L) is estimated by entering Table A or Table B with $_L$, using the column appropriate to the total number of measurements (n). Use Table A if $_L$ has a negative value, or use Table B if $_L$ has a positive value.

3.a.9 In cases where both upper (U) and lower (L) limits are concerned, the percentage of material that will fall within limits is found by adding the percent (P_U) within the upper limit (U) to the percent (P_L) within the lower limit (L) and subtracting 100 from the sum.

Total percent within limits = (P_U P_L) - 100

3.a.10 When determining the percentage within limits when the calculated uality Index (.I.) value is between two tabular values in Table A or Table B, the following procedure is used:

- The difference between the tabular .I. values on either side of the calculated value .I. value will be determined.

- The difference will be divided by 2 and the quotient added to the lower tabular .I. value, resulting in the interpolated .I. value.

- If the calculated .I. is equal to or greater than the interpolated value, the higher listed percent within limits will be used.

- If the calculated .I. is less than interpolated value, the lower listed percent within the limits will be used.

TABLE A
Estimating Percent of Lot Within Limits
(Standard Deviation Method)
Negative Values of Q_U or Q_L

Percent Within Limits	n=3	n=4	n=5	n=6	n=7
50	0.0000	0.0000	0.0000	0.0000	0.0000
49	0.0361	0.0300	0.0281	0.0272	0.0267
48	0.0722	0.0600	0.0562	0.0545	0.0535
47	0.1083	0.0900	0.0843	0.0818	0.0802
46	0.1444	0.1200	0.1124	0.1091	0.1070
45	0.1806	0.1500	0.1406	0.1364	0.1338
44	0.2158	0.1800	0.1689	0.1639	0.1608
43	0.2510	0.2100	0.1972	0.1914	0.1878
42	0.2863	0.2400	0.2256	0.2189	0.2148
41	0.3215	0.2700	0.2539	0.2464	0.2418
40	0.3568	0.3000	0.2823	0.2740	0.2689
39	0.3912	0.3300	0.3106	0.3018	0.2966
38	0.4252	0.3600	0.3392	0.3295	0.3238
37	0.4587	0.3900	0.3678	0.3577	0.3515
36	0.4917	0.4200	0.3968	0.3859	0.3791
35	0.5242	0.4500	0.4254	0.4140	0.4073
34	0.5564	0.4800	0.4544	0.4426	0.4354
33	0.5878	0.5101	0.4837	0.4712	0.4639
32	0.6187	0.5401	0.5131	0.5002	0.4925
31	0.6490	0.5701	0.5424	0.5292	0.5211
30	0.6788	0.6001	0.5717	0.5586	0.5506
29	0.7076	0.6301	0.6018	0.5880	0.5846
28	0.7360	0.6601	0.6315	0.6178	0.6095
27	0.7635	0.6901	0.6619	0.6480	0.6395
26	0.7905	0.7201	0.6919	0.6782	0.6703
25	0.8164	0.7501	0.7227	0.7093	0.7011
24	0.8416	0.7801	0.7535	0.7403	0.7320
23	0.8661	0.8101	0.7846	0.7717	0.7642
22	0.8896	0.8401	0.8161	0.8040	0.7964
21	0.9122	0.8701	0.8479	0.8363	0.8290
20	0.9342	0.9001	0.8798	0.8693	0.8626
19	0.9555	0.9301	0.9123	0.9028	0.8966
18	0.9748	0.9601	0.9453	0.9367	0.9315
17	0.9940	0.9901	0.9782	0.9718	0.9673
16	1.0118	1.0201	1.0125	1.0073	1.0032

TABLE A (continued)
Estimating Percent of Lot Within Limits
(Standard Deviation Method)
Negative Values of Q_U or Q_L

Percent Within Limits	n=3	n=4	n=5	n=6	n=7
15	1.0286	1.0501	1.0469	1.0437	1.0413
14	1.0446	1.0801	1.0819	1.0813	1.0798
13	1.0597	1.1101	1.1174	1.1196	1.1202
12	1.0732	1.1401	1.1538	1.1592	1.1615
11	1.0864	1.1701	1.1911	1.2001	1.2045
10	1.0977	1.2001	1.2293	1.2421	1.2494
9	1.1087	1.2301	1.2683	1.2866	1.2966
8	1.1170	1.2601	1.3091	1.3328	1.3465
7	1.1263	1.2901	1.3510	1.3813	1.3990
6	1.1330	1.3201	1.3946	1.4332	1.4562
5	1.1367	1.3501	1.4408	1.4892	1.5184
4	1.1402	1.3801	1.4898	1.5500	1.5868
3	1.1439	1.4101	1.5428	1.6190	1.6662
2	1.1476	1.4401	1.6018	1.6990	1.7615
1	1.1510	1.4701	1.6719	1.8016	1.8893

TABLE B
Estimating Percent of Lot Within Limits
(Standard Deviation Method)
Positive Values of Q_U or Q_L

Percent Within Limits	n=3	n=4	n=5	n=6	n=7
99	1.1510	1.4701	1.6719	1.8016	1.8893
98	1.1476	1.4401	1.6018	1.6990	1.7615
97	1.1439	1.4101	1.5428	1.6190	1.6662
96	1.1402	1.3801	1.4898	1.5500	1.5868
95	1.1367	1.3501	1.4408	1.4892	1.5184
94	1.1330	1.3201	1.3946	1.4332	1.4562
93	1.1263	1.2901	1.3510	1.3813	1.3990
92	1.1170	1.2601	1.3091	1.3328	1.3465
91	1.1087	1.2301	1.2683	1.2866	1.2966
90	1.0977	1.2001	1.2293	1.2421	1.2494
89	1.0864	1.1701	1.1911	1.2001	1.2045
88	1.0732	1.1401	1.1538	1.1592	1.1615
87	1.0596	1.1101	1.1174	1.1196	1.1202
86	1.0446	1.0801	1.0819	1.0813	1.0798
85	1.0286	1.0501	1.0469	1.0437	1.0413
84	1.0118	1.0201	1.0125	1.0073	1.0032
83	0.9940	0.9901	0.9782	0.9718	0.9673
82	0.9748	0.9601	0.9453	0.9367	0.9315
81	0.9550	0.9301	0.9123	0.9028	0.8966
80	0.9342	0.9001	0.8798	0.8693	0.8626
79	0.9122	0.8701	0.8479	0.8363	0.8290
78	0.8896	0.8401	0.8161	0.8040	0.7964
77	0.8661	0.8101	0.7846	0.7717	0.7642
76	0.8416	0.7801	0.7535	0.7403	0.7320
75	0.8164	0.7501	0.7227	0.7093	0.7011
74	0.7905	0.7201	0.6919	0.6782	0.6703
73	0.7635	0.6901	0.6619	0.6480	0.6395
72	0.7360	0.6601	0.6315	0.6178	0.6095
71	0.7076	0.6301	0.6018	0.5880	0.5846
70	0.6788	0.6001	0.5717	0.5586	0.5506
69	0.6490	0.5701	0.5424	0.5292	0.5211
68	0.6187	0.5401	0.5131	0.5002	0.4925
67	0.5878	0.5101	0.4837	0.4712	0.4639
66	0.5564	0.4800	0.4544	0.4426	0.4354
65	0.5242	0.4500	0.4254	0.4140	0.4073

TABLE B (continued)
Estimating Percent of Lot Within Limits
(Standard Deviation Method)
Positive Values of Q_U or Q_L

Percent Within Limits	n=3	n=4	n=5	n=6	n=7
64	0.4917	0.4200	0.3968	0.3859	0.3791
63	0.4587	0.3900	0.3678	0.3577	0.3515
62	0.4252	0.3600	0.3392	0.3295	0.3238
61	0.3912	0.3300	0.3106	0.3018	0.2966
60	0.3568	0.3000	0.2823	0.2740	0.2689
59	0.3215	0.2700	0.2539	0.2464	0.2418
58	0.2863	0.2400	0.2256	0.2189	0.2148
57	0.2510	0.2100	0.1972	0.1914	0.1878
56	0.2158	0.1800	0.1689	0.1639	0.1608
55	0.1806	0.1500	0.1406	0.1364	0.1338
54	0.1444	0.1200	0.1124	0.1091	0.1070
53	0.1083	0.0900	0.0843	0.0818	0.0802
52	0.0722	0.0600	0.0562	0.0545	0.0535
51	0.0361	0.0300	0.0281	0.0272	0.0267
50	0.0000	0.0000	0.0000	0.0000	0.0000

3.b Resampling of Lot. It is the intent of these specifications that lots will meet specification requirements at the time of submission. If permitted, nonconforming lots that can be corrected may be reworked and sampled.

3.c General Basis of Adjusted Payment. The related adjusted percentage of contract price will be determined by the method designated in the appropriate specification section.

(b) Specifications, Other than Restricted Performance.

1. Responsibility. The Department will be responsible for determining the acceptability of the material and construction. Material will be reviewed for acceptance through the Department s specified acceptance procedures. Sample locations for acceptance testing will be determined by the Department.

Perform sampling and testing for acceptance in the presence of the Inspector, unless otherwise specified. Transport acceptance samples from sampling point to testing site or other designated location in the presence of the Inspector.

The Contractor is responsible for the control and quality of the material and construction.

Prepare a C Plan as specified in Section 106.03(a)2.a and submit it to the Inspector-In-Charge for review at the start of the project. Include C sampling and testing frequencies and action points to initiate corrective measures. Notify the Inspector before performing C sampling and testing. Perform C sampling and testing and report results to the Inspector.

Do not incorporate any material into the work that is determined to be outside the specification limits.

Obtain and test samples according to the Department s PTMs. If the required test method is not specified, use methods described in the AASHTO Standard Specifications for Transportation Materials and Methods of Sampling and Testing, and Supplements, Standards and/or Tentatives of ASTM, or other testing procedures adopted by the Department.

Verification sampling and testing will be performed by the District, unless otherwise specified.

A sampling and testing will be performed or witnessed by the BOPD.

Independent Assurance sampling and testing will be administered by the C AS.

2. QC. Section 106.03(a)2. and as follows:

Provide a plan of the C system to be used for all construction work requiring acceptance testing by the Department, including C test frequencies and action points to initiate corrective measures. Submit a copy of the C Plan to the Project Engineer, to be maintained at the Department s project field office, before the start of work. A C Plan is not required for items specified in Section 901.

3. Compliance Certification of Bulletin Materials. The Contractor is responsible for the control and quality of all materials, both Bulletin and non-Bulletin materials, arriving at the project. Each Bulletin material must be certified to be from a Bulletin source and to be in compliance with the specification requirements for the material. A properly completed and submitted Form CS-4171, Certificate of Compliance, is the means for certification of Bulletin materials. Bulletin materials are defined in Section 106.02(a)1.

The Department reserves the right to sample and test any material for verification that specification requirements are met. Materials of questionable quality delivered to the project will be sampled, tested, and approved by LTS before incorporation in any work. Materials on a reduced certification level may be required to be sampled, tested, and approved by LTS before incorporation in any work. Random field verification samples of the material may be taken by the Representative at the material source, from delivered project material, or at the place of the last manufacturer, fabricator, or producer before delivery. Random A samples may also be taken by the Representative from delivered project material, at the place of supply, or at the place of the last manufacturer, fabricator, or producer before delivery. The random samples will be sent to the LTS for testing.

3.a Form CS-4171 Completion. Form CS-4171 is completed by the manufacturer, fabricator, or producer (Producer) of Bulletin material provided to the project. The Producer maintains the original Form CS-4171 and provides a copy of Form CS-4171 with each direct shipment to the project.

When a Producer sells a Bulletin 15 material to a distributor/supplier (shipper), the Producer provides a copy of Form CS-4171 with each delivery to the shipper. When a shipper provides Bulletin 15 material directly to the project, the shipper completes and signs a new Form CS-4171 and provides a copy with each direct shipment to the project. The shipper will maintain the copy of the Producer s Form CS-4171that they have received.

Form CS-4171 must be properly signed by a legally responsible company official.

3.b Form CS-4171 Submission for Project Shipments. Ensure that Form CS-4171 is received for each project shipment of Bulletin material. Submit to the Representative a properly completed and signed copy of Form CS-4171 for each project shipment. Do not incorporate any Bulletin material in the work until certification arrives on the project, unless otherwise approved by the Representative. Payment for material will be withheld until proper certification documentation is received.

Form CS-4171 may be submitted to the Department either in hard copy format or electronically. Contractors who wish to submit certification documentation to a project electronically, e.g. via e-mail, facsimile or through a PennDOT Project Collaboration Site, must notify the Department at the preconstruction meeting.

3.c Supplemental or Alternate Certification. Certain Bulletin materials require the submission of supplemental CS-4171 certification in addition to Form CS-4171, to provide traceability of materials in multi-step manufacturing processes.

- Epoxy coated or galvanized reinforcement steel requires the submission of supplemental certification Form CS-4171C (Epoxy Coating or Galvanizing Facility) and/or Form CS-4171F (Fabrication Facility).
- Structural steel, aluminum, or precast/prestressed concrete products, produced in a Bulletin 15 approved facility with an on-site Inspector or a Representative, must be stamped with an approved inspection stamp at the plant and certified with a Form CS-4171.
- Steel products containing foreign steel require the submission of supplemental Form CS-4171S.

Certain Bulletin materials require a form of certification other than the Form CS-4171, as identified in the particular material specification.

- Section 701 and Section 702 materials require a properly completed vendor bill of lading.
- Certification of daily asphalt mixtures by submission of Form CS-4171B.

- Certification of locally approved non-Bulletin materials by submission of Form CS-4171LA.

Organize and submit only Forms CS-4171 and supplemental or alternate certifications for material supplied to the project. Submissions containing irrelevant forms or documentation for materials not incorporated into the project will not be accepted.

3.d CS-4171 Record Retention. Retain Form CS-4171 and supplemental and alternate certifications as defined in Section 106.03(b)3.c, for a period of not less than 3 years from the date of the last project shipment. Make files available for inspection and verification by the Department.

Notify shippers that a certification file must be maintained for purchased Bulletin materials to provide an audit trail to the Producer. Certifications for purchased Bulletin materials must be maintained at their place of business for a period of not less than 3 years from the date of the last shipment to the project and must be available for inspection by the Department.

Notify Producers that all component certifications for purchased Bulletin materials must be maintained at their place of business for a period of not less than 3 years from the date of the last shipment to the project and must be available for inspection by the Department.

3.e Levels of Certification for Bulletin 15 Producers. The BOPD determines the Level of Certification for each Producer based on the Producer s ability to comply with the material specifications. The Levels of Certification are defined in Table C. Bulletin 15 will indicate if a Producer is at a certification level other than Level 1. Material provided by Producers listed in Bulletin 15 is approved for use only in its intended application(s).

TABLE C

Levels of Certification for Bulletin 15 Producers		Producer Material Shipment Procedure	Producer Additional Requirements
Level 1	Standard Certification	Ship on Certification with Form CS-4171	None
Level 2	Standard Certification - Reduced	Ship on Certification with Form CS-4171	See Section 106.03(b)3.e.2
Level 3	Lot Approval Certification	Ship only after Material Lot Approval using Modified Certification, with Form CS-4171	See Section 106.03(b)3.e.3
Suspension or Removal	According to the State s Contractor Responsibility Program: • Producer may be suspended or removed from Bulletin 15 for any of the reasons stated in the Bulletin 15 Preface, regardless of Producer certification level. • Failure of Producer to advance above Certification Level 3 will result in PennDOT s initiating action for suspension or removal from Bulletin 15.		

Certain Bulletin materials require supplemental or alternate forms of certification, as specified in Section 106.03(b)3.c.

3.e.1 LEVEL 1 (Standard Certification).

- Initial Level of Certification typically issued to Bulletin 15 listed Producers.
- Material is produced and tested in accordance with the Producer s approved C Plan.
- No known material performance or quality issues exist that warrant a reduced level of certification.
- Material is shipped on certification using Form CS-4171.

3.e.2 LEVEL 2 (Standard Certification - Reduced).

- Reduced Level of Certification issued to Bulletin 15 listed Producers who have exhibited minor/moderate material performance or quality issues.

- Producer is required to work with PennDOT on submission of an improvement plan that may include, but is not limited to, any or all of the following items: a revised C Plan, a failure analysis/action plan to assess why failures are occurring and how to prevent these failures from occurring in the future, correlation testing between in-house and independent lab testing to assist with validating results.
- Material is produced and tested in accordance with the improvement plan approved by PennDOT.
- Material is shipped on certification using Form CS-4171.

3.e.3 LEVEL 3 (Lot Approval Certification).

- This Level of Certification is issued to Bulletin 15 listed Producers who have exhibited major material performance or quality issues.
- Producer is required to work with PennDOT on an improvement plan as defined in Level 2.
- Material cannot be shipped to projects using the standard CS-4171 certification process.
- Producer must arrange for independent, in-plant acceptance testing (IPAT) that will be conducted side-by-side with in-house Producer testing at the designated frequencies in the revised C plan. IPAT will be at the Producer s expense. PennDOT s LTS must approve the Producer s proposed IPAT provider, before it begins.
- Any material lot to be used on a project must be tested and approved by the IPAT as meeting the required PennDOT specification prior to shipment to the project.
- Each material lot meeting the specification may be shipped to a project using a modified certification process as follows: submit, to both the Project Representative and LTS, Form CS-4171 along with a signed letter from the IPAT (on their official letterhead) indicating that the material lot meets testing and specification requirements.
- Correlate results from parallel in-house Producer testing and IPAT testing, and submit to the LTS on a monthly basis.

106.04 USE OF MATERIALS FROM WITHIN THE PROJECT With written permission, material found in the excavation areas and meeting the Department s specifications may be used in the project construction. Material used will be paid for, as specified in Section 110.01. However, replace any portion removed with suitable material, if required to complete the embankments. The replaced quantity will be 110% of the volume of stone or gravel removed and 100% of the volume of sand and other material removed. Do not use reserved material, as specified in Section 104.06, or as indicated in the proposal.

106.05 STORAGE OF MATERIAL

(a) General. Store material to assure preservation of specified quality and fitness for the work.

Stored material, even though accepted before storage, may again be inspected before use in the work. Locate stored material to facilitate prompt inspection and control.

Adhere to the restrictions below for the storage of construction materials with known physical hazards (explosive, flammable, or combustible) or storage of any motorized equipment under any structure with vertical clearance measured:

- Less than 16 feet – No storage is allowed.
- Between 16 feet and 24 feet – Short term operational storage will be allowed provided the materials are stored in an enclosure which meets all ANSI and OSHA requirements for said material(s) and a fire prevention plan has been submitted for the short term operational storage. Short term operational storage is limited to the amount of material and/or equipment required for a 24-hour period.
- Greater than 24 feet – No restriction.

Vertical clearance is measured from the lowest structure member to the ground level below that member.

Do not use private property for storage purposes without written permission of the owner or lessee. Make copies of this permission available to the Department. Restore storage sites to conditions acceptable to property owners and the Department.

(b) Storage of Aggregates. Provide a separate stockpile for each aggregate size and type at cement concrete plants. Do not use aggregates that become segregated or mixed with earth or foreign material.

If divided aggregate bins are used for storage or for proportioning, take measures to prevent mixing of aggregates.

Provide an area for storage of aggregates for use in Portland cement concrete and asphalt concrete. Store aggregates on one of the following constructed according to standard practice:

- Asphalt concrete base course, 4 inches minimum depth.
- Class C concrete, or better, 4 inches minimum depth.

(c) Control of Aggregates. Have aggregates available for use in cement concrete at the proportioning plant in enough time before batching to allow inspection and testing. Handle the aggregates so they may be field tested and accepted, before storing them with previously accepted aggregates. Batch fine and coarse aggregates separately. Properly control uniformity of moisture and uniformity of gradation. Provide a system of water sprays, then use when required, to maintain coarse aggregate moisture control.

During cool and cold weather concrete production, maintain aggregates required for individual concrete placements, whether stored in proportioning bins or stockpiles, at a temperature of not less than 40F before and during batching operations, for a sufficient length of time to eliminate the presence of frost in or around the aggregate particles.

(d) Storage of Reinforcement. Satisfactorily store reinforcement above ground, in a clean and dry condition on a platform, in an orderly manner, plainly marked to facilitate inspection.

106.06 HANDLING AND TRANSPORTATION OF MATERIAL

(a) General. Carefully handle material to preserve quality and fitness for the work and to prevent loss, segregation, or inconsistency in quantities after weighing or measuring for incorporation in the work.

(b) Aggregates. In dry batching operations, measure aggregates or weigh before placing in the compartments of the vehicle, unless otherwise specified or permitted. Clean the vehicles and provide tight batch partitions at least 4 inches higher than the batched aggregate level being hauled, to prevent any spillage from one compartment to another.

(c) Bulk Cement. Bulk cement may be used, as specified in Section 701.

If bulk cement is used, transport to the mixer in acceptable metal, rubber, or plastic, watertight containers or compartments.

(d) Bag Cement. If bag cement is used, dump the contents of the correct number of bags required for each batch into the mixer skip. If permitted, bag cement may be transported from storage to the mixer by placing the correct number of bags per batch on the batched aggregate in the aggregate compartments. When transported, the bag cement may be dumped on the aggregate after having been checked by the inspector, and if done not more than 100 feet from the mixer. Bag cement that is allowed to lie on the batched aggregates longer than 2 hours, or cement dumped on the batched aggregate longer than 1 hour, will be rejected.

106.07 UNACCEPTABLE MATERIAL

(a) Restricted Performance Specifications.

1. Acceptance or Rejection. Following the application of the appropriate acceptance plan, the Representative s decision will be final as to the acceptance, rejection, or acceptance at an adjusted price of sampled lots.

2. Disposition of Lots. If permitted, lots not conforming to specifications may be reworked and resubmitted for acceptance sampling. For nonconforming lots that are not adaptable to correction by reworking, remove and replace them, have them accepted without payment, or have them accepted at an adjusted price as stated in the specifications or, if not stated, as directed.

(b) Specifications, Other than Restricted Performance. Material not conforming to the requirements of the specifications, whether in place or not, will be rejected. Remove such material promptly from the site of the work, unless otherwise directed. Do not return rejected material to the work site until defects have been corrected and the material has been accepted for use.

(c) Serviceable Precast or Prestressed Concrete, Fabricated Structural Steel and Aluminum Products. Plant produced fabricated materials or products having materials substitutions, dimensional deviations, specifications deficiencies, or damage which result in materials or products which may be serviceable but, do not meet all contract requirements will be addressed as follows:

1. Minor Deficiency or Defect. For materials or products with one or more minor deficiencies or defects, resolution of the deficiencies or defects will be made directly by the precaster or fabricator with the BDTD s Structural Materials Section. Minor defects and deficiencies are generally defined as those which will not require:

- engineering design review
- revisions to approved installation or erection plans or methods
- anticipated premature maintenance or rehabilitation

The Structural Materials Section may determine that one or more of the minor deficiencies or defects are actually significant deficiencies or non-conformances and require the precaster or fabricator to resolve the deficiency or defect as a significant deficiency or non-conformance as specified in Section 106.07(c)2.

2. Significant Deficiency or Non-Conformance. For materials or products having one or more significant deficiencies or non-conformances, which cannot be corrected to meet the contract specifications and which the Department determines may require one or more of the bulleted items listed in Section 106.07(c)1., submit documentation to support acceptance of the material or product (provided by the precaster or fabricator) and a request for Department evaluation and final disposition of the materials or products.

Where visible defects are present, or when otherwise requested, include detailed sketches, drawings, or photographs along with the supporting documentation form the precaster or fabricator to support acceptance of the material or product. Include a detailed repair procedure to correct the deficiency, if applicable.

For requests submitted for acceptance of the material or product as is , provide supporting justification to demonstrate that the significant deficiency or non-conformance will not result in additional constructability issues during erection or construction or unanticipated premature maintenance work. Obtain approval of any revisions required to the shop drawings to reflect as built conditions prior to shipment.

Submit engineering calculations, when required or requested, to support the acceptability of the significant deficiency or non-conformance, sealed by a registered Professional Engineer that is licensed in the State. Submittals must include a statement by the Engineer that the defect will not compromise either the structural capacity or service life of the original design.

Submit the above to the District Assistant Construction Engineer with copies to the following:

- Chief Structural Materials Engineer, Bridge Design and Technology Division, Bureau of Project Delivery
- District Structural Control Engineer
- District Bridge Engineer
- Chief Bridge Engineer, Bridge Design and Technology Division, Bureau of Project Delivery (when calculations are required or requested).

Include the following minimum information on a cover page, attached to the submission:

- ECMS or other contract identification including State Route, Section and County
- Structure Number, if applicable
- Specific identification of the affected unit(s), i.e. girder-beam-culvert number, etc.
- Anticipated shipping date
- Detailed sketches, drawings or photographs of the defect, if visible or when requested.

After evaluation, the disposition of the material or product, including any conditions of acceptance, will be provided by the Chief Structural Materials Engineer from information provided by the Engineering District. Replace materials or products which are rejected via this policy with those complying with the contract specifications and requirements.

106.08 DEPARTMENT FURNISHED MATERIAL The Department will furnish material, if specified in the proposal, in the quantities required. Material will be delivered or made available at the point specified.

The cost of handling and placing material after delivery will be included in the contract price for the item.

After delivery and acceptance by the Contractor, the cost of replacing material due to shortages, deficiencies, or damage, including demurrage charges, will be deducted from money due or to become due.

106.09 PENNSYLVANIA TRADE PRACTICES ACT This section does not apply to projects which are partially or totally financed with Federal funds.

(a) General. Pursuant to the PA Trade Practices Act, Act 226-1968, the Department will not specify, purchase, or permit to be furnished or used in any contract aluminum or steel products as set forth below made in the countries set forth below.

The Department may utilize the discretionary waiver provision of Act 3-1978 as to steel products. As to aluminum products, if the sole source is from a banned country relief may be permitted under the Statutory Construction Act, 1 PA C.S. 1901 et seq.

1. Brazil. Welded carbon steel pipes and tubes carbon steel wire rod tool steel certain stainless steel products including hot-rolled stainless steel bar stainless steel wire rod and cold-formed stainless steel bar pre-stressed concrete steel wire strand hot-rolled carbon steel plate in coil hot-rolled carbon steel sheet and cold-rolled carbon steel sheet.

2. Spain. Certain stainless steel products, including stainless steel wire rod, hot-rolled stainless steel bars, and cold-formed stainless steel bars pre-stressed concrete steel wire strand certain steel products, including hot-rolled steel plate, cold-rolled carbon steel plate, carbon steel structural shapes, galvanized carbon steel sheet, hot-rolled carbon steel bars and cold-formed carbon steel bars.

3. South Korea. Welded carbon steel pipes and tubes hot-rolled carbon steel plate hot-rolled carbon steel sheet and galvanized steel sheet.

4. Argentina. Carbon steel wire rod and cold-rolled carbon steel sheet.

106.10 BUY AMERICA PROVISIONS AND CONVICT PRODUCED MATERIALS This section only applies to projects partially or totally financed with Federal funds.

(a) Buy America Provisions. Furnish steel or iron materials, including coating for permanently incorporated work according to 23 CFR 635.410 and as follows:

- Pig iron and processed, pelletized, and reduced iron ore manufactured outside of the United States is acceptable for use in domestic manufacturing process for steel and/or iron materials.

- All manufacturing processes of steel or iron materials in a product, including coating and any subsequent process that alters the steel or iron material s physical form or shape, or changes its chemical composition are to occur within the United States. This includes rolling, extruding, machining, bending, grinding, drilling, and coating. Coating includes all processes that protect or enhance the value of the material, such as epoxy coatings, galvanizing or painting.

- Provide certification to the Inspector-in-Charge, that all manufacturing processes for steel and iron materials in a product, including coating, have occurred in the United States certify as specified in Section 106.01.

Products manufactured of foreign steel or iron materials may be used, provided the cost of such products as they are delivered to the project does not exceed 0.1% of the total contract amount, or 2,500, whichever is greater.

(b) Convict Produced Materials. Pursuant to 23 CFR 635.417, materials produced by convict labor after uly 1, 1991 may not be used for Federal-aid highway construction projects, unless produced at a prison facility which had been producing convict-made materials for Federal-Aid construction projects before uly 1, 1987.

Material produced by convicts who are on parole, supervised release, or probation from a prison may be incorporated in a Federal-Aid highway construction project.

TR-4126A

AGGREGATE REPORT

☐ FINE AGG. ☑ COARSE AGG. ☐ ANTI SKID	☐ ACCEPTANCE ☑ VERIFICATION ☐ INFORMATION	☑ CONSTRUCTION ☐ MAINTENANCE	P.O./CONT. NO
MAT'L SPEC TYPE **#57**	DATE SAMPLED	ITEM NUMBER	ITEM QUANTITY

PRODUCER/LOCATION **Flint's Stone & Gravel**

LOT NO. ______

TON(NES)____TO ______

SYS	SR/PO	SPUR	PHA	SEC	ORG	CO

☐ GRAVEL ☐ SAND
☐ SLAG ☐ COKE
☑ STONE ☐ CINDERS

TON(NES) SHIPPED:
TODAY ______
TO DATE ______
BALANCE ______

SUBLOT NO.	1		2		3		**SPEC. LIMITS**		**STATISTICAL ANALYSIS**		
TON(NE) SAMPLED											
SIEVE	**MASS (WT)**	**%**	**MASS (WT)**	**%**	**MASS (WT)**	**%**	**L**	**U**	**X**	**S**	**PWL**
100 mm (4")											
90 mm (3 1/2")											
75 mm (3")											
63 mm (2 1/2")											
50 mm (2")											
37.5 mm (1 1/2")	**27.00**	**100**	**25.00**	**100**	**25.40**	**100**		**100**	**100**	**0.0**	**100**
31.5 mm (1 1/4")											
25.0 mm (1")	**26.80**	**99**	**24.70**	**99**	**25.20**	**99**	**95**	**100**	**99**	**0.0**	**100**
19.0 mm (3/4")											
12.5 mm (1/2")	**6.20**	**23**	**4.70**	**19**	**8.60**	**34**	**25**	**60**	**25.3**	**7.8**	**?**
9.5 mm (3/8")											
8.0 mm (5/16")											
4.75 mm (#4)	**0.60**	**2**	**0.60**	**2**	**0.60**	**2**	**0**	**10**	**2**	**0.0**	**100**
2.36 mm (#8)	**0.50**	**2**	**0.40**	**2**	**0.50**	**2**	**0**	**5**	**2**	**0.0**	**100**
1.18 mm (#16)											
600 μm (#30)											
425 μm (#40)											
300 μm (#50)											
150 μm (#100)											
75 μm (#200)											
INITIAL DRY MASS (WT)	**27.00**		**25.00**		**25.40**						
MAT'L FINER THAN 75μm (# 200)(FINAL WGT)	**3733.40**	**0.47**	**3600.70**	**0.45**	**3499.10**	**0.50**	**0**	**1**	**0.47**	**0.0**	**100**
CRUSHED FRAG MASS (WT) % (FINAL WGT)											
UNIT WEIGHT KG/M³ (LBS/CF)											
COEFFICIENT OF UNIFORMITY											
WEIGHT USED FOR FINE GRADATION											
FACTOR											

MATERIAL TYPE: **A57**

TESTED BY: Rocco Crusher

DEPT. INSPECT. Sam Stone

WITNESSED BY:

SOURCE TECH.

REVIEWED BY:

COUNTY MGR.

D.M. UNIT

DIST. ENGR.

PWL ____ ? ____

PAY ______ %

$$\frac{\text{WET MASS(WT)} - \text{DRY MASS(WT)}}{\text{DRY MASS (WT)}} \times 100 = \text{\% MOISTURE}$$

#200 Wash Start Wgt.	**3750.90**	**3617.00**	**3516.80**
Crush Cnt. Start Wgt.			

REMARKS

$$\text{AVERAGE} = X = \frac{\sum_{i=1}^{n} X_i}{n}$$

$$\text{STANDARD DEVIATION} = S = \sqrt{\frac{\sum_{i=1}^{n} (X_i - X)^2}{n-1}}$$

$$Q_u = \frac{(U - X)}{S} \qquad Q_L = \frac{(X - L)}{S}$$

$PWL = (P_U + P_L) - 100$

Percent Within Limits Calculations

a. Standard Deviation

$$S = \sqrt{\sum_{i=1}^{n} \frac{(x_i - \bar{x})^2}{n-1}}$$

n = number of samples
x_i = individual sample
x = average value of n samples:

$$\bar{x} = \frac{\sum_{i=1}^{n} x_i}{n}$$

- Standard Deviation Example n=5

$$x_i = \{10,5,50,25,35\}$$

$$\sum_{i=1}^{n} x_i = 125 \qquad \bar{x} = \frac{125}{n} = \frac{125}{5} = 25$$

x_i	$\bar{x}$	$x_i - \bar{x}$	$(x_i - \bar{x})^2$
10	-25	= -15	225
5	-25	= -20	400
50	-25	= 25	625
25	-25	= 0	0
35	-25	= 10	100

$$\sum_{i=1}^{n}((x_i - \bar{x})^2) = \quad 1{,}350$$

$$S = \sqrt{\frac{\sum_{i=1}^{n}(x_i - \bar{x})^2}{n-1}} = \sqrt{\frac{1350}{4}} = \sqrt{337.5} \approx 18.4$$

- Same Average, Different Standard Deviation:

$$\begin{array}{r} 2 \\ 10 \\ \underline{+\,15} \\ 27/3 = 9 \end{array} \qquad \begin{array}{rr} 2-9=(-7)^2= & 49 \\ 10-9=(1)^2= & 1 \\ 15-9=(6)^2= & \underline{+\,36} \\ & 86 \end{array} \qquad S=\sqrt{\frac{86}{3-1}}=\sqrt{43} \quad \approx 6.56$$

$$\begin{array}{r} 8 \\ 9 \\ \underline{+\,10} \\ 27/3 = 9 \end{array} \qquad \begin{array}{rr} 8-9=(-1)^2= & 1 \\ 9-9=(0)^2= & 0 \\ 10-9=(1)^2= & \underline{+\;1} \\ & 2 \end{array} \qquad S=\sqrt{\frac{2}{3-1}}=\sqrt{1} \quad \approx 1.00$$

- Different Average, Same Standard Deviation:

$$\begin{array}{r} 38 \\ 39 \\ \underline{+\,40} \\ 117/3 = 39 \end{array} \qquad \begin{array}{rr} 38-39=(-1)^2= & 1 \\ 39-39=(0)^2= & 0 \\ 40-39=(1)^2= & \underline{+\;1} \\ & 2 \end{array} \qquad S=\sqrt{\frac{2}{3-1}}=\sqrt{1} \quad \approx 1.00$$

- Average ÷ Standard Deviation:

$$\frac{9.0}{6.56}\approx 1.4 \qquad \frac{9.0}{1.0}=9.0 \qquad \frac{39}{1.0}=39.0$$

$\frac{\text{Average}}{\text{Standard Deviation}}$: The larger the number, the less variance

$$Q_L=\frac{\bar{x}-L}{s} \quad \text{or} \quad Q_u=\frac{U-\bar{x}}{s} \quad \rightarrow \oplus \text{ or } \ominus \text{ values}$$

+ values → less variability → x falls between U and L
- values → more variability → x falls outside U and L

b. Quality Index

$$Q_u = \frac{U - \bar{x}}{s} \qquad Q_t = \frac{\bar{x} - L}{s}$$

Q = Quality Factor
U = Upper Specification Limit
L = Lower Specification Limit

c. Verification Report Calculations

1. Calculate the average of three results for ½" screen: n = 3

$$\begin{aligned} x_1 &= \;\;23 \\ x_2 &= \;\;19 \\ x_3 &= \underline{+34} \\ & \;\;\;\;76 \end{aligned} \qquad \bar{x} = \frac{76}{3} = 25.3$$

2. Calculate the standard deviation, s:

$$s = \sqrt{\frac{\sum_{i=1}^{n}(x_i - \bar{x})^2}{n-1}}$$

x_i	$x_i - \bar{x}$		$(x_i - \bar{x})^2$
23	$23 - 25.3$	$= -2.3$	5.29
19	$19 - 25.3$	$= -6.3$	39.69
34	$34 - 25.3$	$= 8.7$	+75.69
			120.67

$$s = \sqrt{\frac{120.67}{2}} = \sqrt{60.34} \approx 7.76 \rightarrow 7.8$$

3. Calculate the Quality Index, Q:
Specifications out on low side → Q_L

$$Q_L = \frac{\overline{x - L}}{s} = \frac{25.3 - 25}{7.8} = \frac{0.3}{7.8} \approx +0.0385$$

PWL Worksheet

Find the **Average** of three screens. Fill in the percent passing for each sample, (only for the screen size that failed)

__________ plus __________ plus __________ = __________ divided by **3** = __________ (Average)
(sample #1) (sample #2) (sample #3) (Round off)

Find the **Standard Deviation** of three screens:

__________ minus __________ = __________ times itself = __________(A)
(sample #1) (average)

__________ minus __________ = __________ times itself = __________(B)
(sample #2) (average)

__________ minus __________ = __________ times itself = __________(C)
(sample #3) (average)

__________ plus __________ plus __________ = __________ divided by **2** = __________ (D)
(A) (B) (C)

__________ then press √ (square root button) to find __________________ (Standard Deviation)
(D)

If the failing screen exceeds the UPPER spec limit, then find QU.

__________ minus __________ = __________ divided by _______________ = _______________ (QU)
(upper spec) (average) (standard deviation)

If the failing screen exceeds LOWER spec limit, then find QL.

__________ minus __________ = __________ divided by _______________ = _______________ (QL)
(average) (lower spec) (standard deviation)

Estimated the **Screen PWL** from Table A (Negative numbers) or Table B (Positive numbers) in Pub 408, Section 106.03(a).

__________ (Screen PWL)

Average all the screen size PWL's to find the **Total PWL**.
(For all "In Spec" screen sizes, PWL = 100)

__________ (Total PWL)

4. Determine PWT:
   Positive number: Go to chart in PennDOT Publication 408;
   Section 106, Table B.

   Look for Positive Value Q_t of 0.0385
   Note 0.0361 is nearest value to 0.0385 → (51)
   PWT = 51

5. Calculate PWL:
   All other screen splits are within specifications → 100

$$\begin{array}{r} 100 \\ 100 \\ 51 \\ 100 \\ 100 \\ \underline{+\ 100} \\ 551 \end{array}$$

$$\frac{551}{6} = \text{(92\%)}$$

Aggregate Source Quality Failures; refer to Bulletin 14, page F-3

On requalification, Na2SO4 soundness loss = 11%
DME resamples n = 3 at least quarterly for next 6 months.
Calculate PWL for last 5 years:

(Two Examples)

- Example 1.

Last 5 years – assume n = 5 and Na2SO5 losses: {4,4,3,3,11}

x_i	$x_i - \bar{x}$	$(x_i - \bar{x})^2$
4	$4 - 5 = -1$	1
4	$4 - 5 = -1$	1
3	$3 - 5 = -2$	4
3	$3 - 5 = -2$	4
+ 11	$11 - 5 = -6$	+ 36
$\bar{x} = 25/5 = 5$		46

$$s = \sqrt{\frac{46}{4}} = \sqrt{11.5} \approx \boxed{3.4} \qquad Q_u = \frac{10 - 5}{3.4} = \boxed{+1.5}$$

PWL = 96%, *therefore passes*

- Example 2.

n = 5, Na2SO4 losses: {8,9,9,8,11}

x_i	$x_i - \bar{x}$	$(x_i - \bar{x})^2$
8	$8 - 9 = -1$	1
9	$9 - 9 = 0$	0
9	$9 - 9 = 0$	0
8	$8 - 9 = -1$	1
+ 11	$11 - 9 = 2$	+ 4
$\bar{x} = 45/5 = 9$		6

$$s = \sqrt{\frac{6}{4}} = \sqrt{1.5} \approx \boxed{1.22}$$

$$Q_u = \frac{10 - 9}{1.2} = \boxed{+0.8}$$

PWL = 78% → Step 6; Written report required; may suspend from Bulletin 14.

APPENDIX

SPECIFIC GRAVITY AND ABSORPTION OF COARSE AGGREGATE

Test Method Evaluated: AASHTO T85 ASTM C127	
Person to be Evaluated	
Date the test method was read and understood	
Evaluator	
Date Evaluated	
Next Evaluation Date	

APPARATUS

1. Sample container a wire basket of 3.35-mm (No. 6) mesh or finer ....
2. Water tank capable of completely submerging the sample equipped with an overflow outlet ....
3. Suspension apparatus with center of suspension apparatus properly located with respect to center of balance pan or other point of contact with balance...
4. Immersion water, temperature is 23.0±1.7°C (73.4±3°F)..
5. Large absorbent cloth ………………………………………………………………...
6. Balance Class G5 ....
7. Sieves, 4.75 mm (No. 4) or other sizes as needed ....
8. Oven capable of maintaining 110±5°C (230±9°F)..

PROCEDURE

1. Obtain sample by (T248 / C702) ....
2. Sieve out all –No.4 material…………………………………………………………………………………………....
3. Sample mass as follows: #57and #67 – 4200 grams and #8 – 2200 grams……………..………………………………
4. Wash sample to clean surfaces of particles ....
5. Dried to constant mass at 110±5°C (230±9°F) and cooled to room temperature for 1 to 3 hours (for up to 1 -in. nominal maximum size, longer for larger sizes)…………………………………………………………………….……………
6. Cover with water for 15 to 19 hours ....
7. Roll in cloth to remove visible films of water ....
8. Wipe larger particles individually and avoid evaporation ....
9. AASHTO: If sample dries past SSD, immerse sample in water for 30 minutes and re-start drying ....
10. Weigh the material at SSD to nearest 1 g or 0.1% of sample mass (whichever is greater)..
11. Place sample immediately in wire mesh basket and immerse into the water bath...
12. Remove entrapped air before weighing by shaking container while immersed ....
13. Determine the mass in water at 23.0±1.7°C (73.4±3°F) to nearest 1 g or 0.1% of sample mass (whichever is greater……...........
14. Dry to constant mass at 110±5°C (230±9°F) and cool to room temperature for 1 to 3 hours (or until aggregate has cooled to comfortable handling temperature, approximately 50°C)...
15. Determine the oven dried mass to nearest 1 g or 0.1% of sample mass (whichever is greater) ....

Comments:

Coarse Aggregate Specific Gravity and Absorption Sample

Sample			AVG
A			
B			
C			
BSG			
BSGSSD			
ASG			
ABS			

Sample			AVG
A			
B			
C			
BSG			
BSGSSD			
ASG			
ABS			

A = mass of oven-dry specimen in air, g (A on AW19)

B = mass of saturated surface-dry specimen in air, g (B on AW19)

C = mass of saturated surface-dry specimen in water, g (C on AW19)

BSG = A/(B-C)

BSGSSD = B/(B-C)

ASG = A/(A-C)

ABS = [(B-A)/A] x 100

SPECIFIC GRAVITY AND ABSORPTION OF FINE AGGREGATE

Test Method Evaluated: AASHTO T84 ASTM C128	
Person to be Evaluated	
Date the test method was read and understood	
Evaluator	
Date Evaluated	
Next Evaluation Date	

PROCEDURE

SSD Sample Preparation

1. Obtain sample by AASHTO T248 (ASTM C702)………………………………………………………………………
2. Sample should weigh approximately 1000 g……………………………………………………………………….
3. Dry sample to constant weight at 110º _ 5º C (230º _ 9º F)……………………………………………………….
   NOTE: Oven drying is unnecessary if naturally moist condition is desired.
4. Allow to cool to comfortable handling temperature………………………………………………………………….
5. Cover sample with distilled water...
6. Allow to stand for 15 to 19 hours………………………………………………………………………………………
7. Decant excess water without losing fines…………………………………………………………………………
8. Spread sample on flat, nonabsorbent surface..
9. Dry by a current of warm air, stirring to ensure uniform drying…………………………………………………...
10. Gently break up agglomerations with finger pressure…………………………………………………………….
11. Place mold wide side down on flat, nonabsorbent surface……………………………………………………….
12. Fill mold to overflowing with the sample...
13. Tamp 25 times with 5 mm (0.2 inch) drop, distributing along surface of the sample………………………………..
14. Allow tamper to free fall under gravitational attraction…………………………………………………………….
15. Remove loose sand from around base and lift mold vertically……………………………………………………
16. If sample slumps, add water, keep sample covered, and allow to stand 30 minutes…………………………………….
17. Continue drying and repeating slump test at frequent intervals until sample slumps slightly………………………….

Test Procedure

1. Partially fill pycnometer with water and 500 _ 10g of sample…………………………………………………
2. Record the mass of SSD sample to 0.1g…………………………………………………………………………..
3. Fill pycnometer to 90% of capacity and agitate to eliminate air bubbles……………………………………………….
4. Adjust temperature of contents to 23 º _ 1.7º C (73.4º_ 3º F)……………………………………………………..
5. Adjust water level to calibrated capacity, and weigh pycnometer and contents……………………………………...
6. Remove sample and dry to constant weight at 110º _5º C (230º _ 9º F)……………………………………………
7. Air cool sample to room temperature for 1 _ 0.5 hour and weigh...
8. Use the proper calibrated pycnometer weight in calculations……………………………………………………
9. Determine all weights to nearest 0.1 g..

Pycnometer Calibration

1. 500 ml Volumetric Flask (or larger)………………… ……………………………………………..
   a. *(or)*a Fruit ar with Pycnometer top……………………...........……………………………………...
   b. *(or)* a Le Chatelier Flask (AASHTO T133)……………………………………………………………
2. The apparatus shall have a space of at least 10 mL between the highest gradation mark and the lowest point of grinding for the glass stopper……………………………………………………………………………………….
3. The apparatus shall be made of glass…………………………………………………………………………………
4. The neck of the Pycnometer shall be graduated from 0 to 1 mL and from 18 to 24 mL…………………………………..
5. The bottle and stopper will have identical permanent identification marking…………………………………………..
6. The unit of volume (mL) will be marked above the highest graduation…………………………………………...
7. The container will be calibrated to a volume exceeding 50% than the volume required to accommodate the test sample……………… ………………………………………………………

The Pycnometer will be calibrated at 23 º _ 1.7º C (73.4º_ 3º F)………………………………………………………….

Fine Aggregate Specific Gravity and Absorption Sample

Sample			AVG
A			
B			
S			
C			
BSG			
BSGSSD			
ASG			
ABS			

Sample			AVG
A			
B			
S			
C			
BSG			
BSGSSD			
ASG			
ABS			

A = mass of oven-dry specimen in air, g

B = mass of pycnometer filled with water, g

S = mass of saturated surface-dry specimen, g

C = mass of pycnometer with specimen and water to calibration mark, g

BSG = A/(B+S-C)

BSGSSD = S/(B+S-C)

ASG = A/(B+A-C)

ABS = [(S-A)/A] x 100

Data Set: Specific Gravity and Absorption Sample Problems

Coarse	Oven Dry (A)	SSD in Air (B)	SSD in Water (C)
Sample 1	2256.7	2282.4	1439.7
Sample 2	2499.4	2518.4	1593.4
Sample 3	4483.9	4526.2	2822.5
Sample 4	4572.5	4613.9	2925.4
Sample 5	4498.5	4792.2	2782.8
Sample 6	4562.2	4618.4	2896.5

Fine	Oven Dry (A)	Pycnometer filled with water (B)	SSD Specimen (S)	Pycnometer with specimen and water to calibration mark (C)
Sample 1	491.6	679.8	502.3	993.4
Sample 2	494.7	678.7	505.6	991.1
Sample 3	488.8	675.8	500.3	983.8
Sample 4	493.2	677.7	501.2	987.1
Sample 5	498.6	679.8	504.2	1001.4
Sample 6	491.7	677.7	502.3	987.5

Answers: Specific Gravity and Absorption Sample Problems

Coarse	Bulk Specific Gravity	Bulk Specific Gravity SSD	Apparent Specific Gravity	Absorption
Sample 1	2.678	2.708	2.762	1.14
Sample 2	2.702	2.723	2.759	0.76
Sample 3	2.632	2.657	2.699	0.94
Sample 4	2.708	2.733	2.776	0.91
Sample 5	2.239	2.385	2.622	6.53
Sample 6	2.650	2.682	2.739	1.23

Fine	Bulk Specific Gravity	Bulk Specific Gravity SSD	Apparent Specific Gravity	Absorption
Sample 1	2.605	2.662	2.762	2.18
Sample 2	2.561	2.617	2.714	2.2
Sample 3	2.542	2.602	2.704	2.35
Sample 4	2.571	2.613	2.683	1.62
Sample 5	2.731	2.761	2.817	1.12
Sample 6	2.554	2.609	2.703	2.16

LABORATORY TESTING SECTION

Method of Test for

AMOUNT OF MATERIAL FINER THAN 75 µm (NO. 200) SIEVE IN AGGREGATE

This PTM is a modification of AASHTO T 11. The full standard is available from American Association of State Highway and Transportation Officials, 444 N. Capitol Street, N.W., Suite 249, Washington, D.C. 20001 (www.transportation.org).

The modifications to AASHTO T 11 are as follows:

1. SCOPE

1.2 Two procedures are included, one using only water for the washing operation, and the other including a wetting agent to assist the loosening of the material finer than the 75 µm (No. 200) sieve from the coarser material.

2. REFERENCED DOCUMENTS

2.3. Pennsylvania Test Method:

2.3.1. PTM No. 607, Sampling Stone, Slag, Gravel, Sand and Stone Block for Use As Highway Materials

5. APPARATUS AND MATERIALS

5.4 Oven- An oven of sufficient size, capable of maintaining a uniform temperature of 110 °C ± 5 °C (230F ± 9F). Hot plates either electric or gas, maybe used when test results must be obtained quickly in the field. When test results are disputed, referee samples shall be tested using ovens as described above.

6. SAMPLING

6.1 Sample the aggregates in accordance with PTM No. 607.

6.2 Obtain a sample in accordance with PTM No. 607. Thoroughly mix the sample of aggregate to be tested and reduce the quantity to an amount suitable for testing using the applicable methods described in AASHTO R 76. The sample for test shall not be less than the appropriate mass dried material as shown in the following table:

AASHTO / PA Number	Minimum Mass of Sample	
	Kg	lb
# 3	5.0	10.0
# 5	5.0	10.0
# 57	3.5	7.7
# 67	2.5	5.0
# 7	2.5	5.0
# 8	1.0	2.0
2A	4.0	8.8
OGS	4.0	8.8
Type A Fine Aggregate	0.5	1.0

11. REPORT

11.1 Report the percentage of material finer than the 75 μm (No. 200) sieve by washing to the nearest 0.01%.

WASH TEST OF MATERIALS FINER THAN #200

Test Method Evaluated: AASHTO T11 PTM 100 ASTM C702	
Person to be Evaluated	
Date the test method was read and understood	
Evaluator	
Date Evaluated	
Next Evaluation Date	

PROCEDURE

1. Obtain test sample by AASHTO T248 (ASTM C702)……………………………………………………
2. Minimum sample size for fine aggregate based on PTM will be 500g………………………………
3. Select sample size for PTM based on the following table……………………………………………

PTM No. 100	
AGGREGATE SIZE	**MINIMUM SAMPLE WEIGHT in grams**
#8	1000
#57	3500
#67	2500
2A, 2RC, OGS	4000

4. Dry sample to constant weight at 110º _5º C (230º ._ 9º F)……………………………………………
5. Determine mass of test sample to nearest 0.1% of the original dry sample mass……………………
6. Place in container and cover with water……………………………………………………………
7. Vigorously agitate the contents of the container……………………………………………………
8. Confirm complete separation of the fine and coarse particles………………………………………
9. Pour wash water through nested sieves ……………………………………………………………
10. Confirm wash water is free of coarse particles...
11. Continue operation until wash water is clear..
12. Return material retained on the nested sieves to the washed sample…………………………………
13. Decant excess water from the washed sample through the No. 200 sieve......................................
14. Dry sample to constant weight at 110º _5º C (230º ._ 9º F)……………………………………………
15. Determine mass to nearest 0.1% of the original dry sample mass…..………………………………
16. Calculate percentage of materials finer than 75- m (No. 200) see Note:
17. Report the percentage of material finer than the 75- m (No. 200) sieve to the nearest 0.01%.......................................

NOTE: (original dry mass of sample – dry mass of sample after washing) / original dry mass of sample x 100

NOTE: Mechanical washing is permitted only if the results using the mechanical washing device are consistent with those obtained by manual washing and if degradation of the sample is avoided.

COMMENTS:

LABORATORY TESTING SECTION

Method of Test for

SIEVE ANALYSIS OF COARSE AND FINE AGGREGATE

This PTM is a modification of AASHTO T-27. The full standard is available from American Association of State Highway and Transportation Officials, 444 N. Capitol Street, N.W., Suite 249, Washington, D.C. 20001 (www.transportation.org).

The modifications to AASHTO T-27 are as follows:

6. APPARATUS

6.4 Oven- An oven of appropriate size capable of maintaining a uniform temperature of 110 ± 5°C (230 ± 9°F). Hot plates either electric or gas may be used when test results must be obtained quickly. Confirmation samples shall be tested using ovens as described in this section.

7. SAMPLING

7.1 Sample the aggregate in accordance with PTM 607.

7.3 Fine Aggregate - The size of the test sample of aggregate, after drying shall have an approximate mass of 500 grams.

7.4 Coarse Aggregate- The mass of the test sample of coarse aggregate shall conform with the following:

AASHTO / PA Number	Minimum Mass of Sample	
	Kg	lb.
# 1	Usual inspection per section 850.2 (a) 1	2, Pub. 408
# 3	20	44
# 5	10	22
# 57	10	22
# 67	10	22
# 7	10	22
# 8	5	11
# 10	1	2
2A	15	33
OGS	15	33

7.7.1 Delete this section
7.7.2 Delete this section
7.7.3 Delete this section

8. PROCEDURE

8.4 (For Fine Aggregates) - Sieve for a sufficient period and in such a manner that, after completion, not more than 0.5 percent by mass of the total sample passes any sieve during 1 minute of continuous hand sieving performed as follows: Hold the individual sieve, provided with a snug fitting pan and cover, in a slightly inclined position in one hand. Strike the side of the sieve sharply with an upward motion while holding the sieve in the other hand, at the rate of about 150 times per minute. Turn the sieve about one-sixth of a revolution at intervals of about 25 strokes.

(For Coarse Aggregates) - Sieve for a sufficient period and in such a manner that, after completion, not more than 0.5 percent by mass of the total sample passes any sieve during 1 minute of continuous mechanical shaking as follows: Weigh the material retained on each individual sieve after the initial shaking period. Individually place each sieve with the material retained on the sieve back into the mechanical shaking device and sieve for an additional minute. In determining the sufficiency of sieving for sizes larger than 4.75 mm (No. 4) sieve, limit the material on the sieve to a single layer of particles.

Note- The Sufficiency of Sieving procedure is documented in PTM 608.

8.7 Determine the mass of each size increment by weighing on a scale or balance conforming to the requirements specified in Section 6.1 to the nearest 0.1 percent of the total original dry sample mass. The total mass of the material after sieving shall check closely with the original mass of sample placed on the sieves. If the amounts differ by more than 0.8 percent, based on the original dry sample mass, the results shall not be used for acceptance purposes.

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Commonwealth of Pennsylvania
Department of Transportation

PA Test Method No. 501
October 2013
3 Pages

LABORATORY TESTING SECTION

Method of Test for

DETERMINATION OF FINENESS MODULUS OF FINE AGGREGATES

1. SCOPE

1.1 This procedure is used for determining the Fineness Modulus of fine aggregates.

2. APPARATUS

2.1 The apparatus shall be as specified in PTM 616.

3. PROCEDURE

3.1 The sieve analysis of the given fine aggregate shall be conducted in accordance with PTM 616.

4. CALCULATIONS

4.1 The calculations for the Fineness Modulus of a given sample of fine aggregate shall be made upon completion of the sieve analysis.

4.2 All of the sieves that are necessary for the determination of the Fineness Modulus are as follows: 150   m, 300   m, 600   m, 1.8 mm, 2.36 mm and the 4.75 mm (No. 100, 50, 30, 16, 8 and 4) sieves.

4.3 Determine the percentage retained on each of the specified sieves by subtracting the percentage passing a given sieve from 100 percent. Percentages shall be rounded off to the nearest whole number (Note 1).

4.4 Obtain the Fineness Modulus by adding the total percentages of a sample of the aggregate retained on each of the specified series of sieves, and dividing the sum by 100.

5. REFERENCES

5.1 PTM 616

Note 1. An example of a sieve analysis and the procedure used for calculating the Fineness Modulus is shown below.

(Column 1) Sieve Size	(Column 2) Mass Passing	(Column 3) Percent Passing	(Column 4) Percent Retained
150 m (No.100)	12.7	2	98
300 m (No. 50)	79.6	16	84
600 m (No. 30)	223.9	44	56
1.18 mm (No. 16)	376.7	74	26
2.36 mm (No. 8)	458.7	90	10
4.75 mm (No. 4)	502.1	98	1
9.50 mm (No.3/8)	508.5	100	(Not included in calculations)

$$\text{Fineness Modulus} = \frac{\text{Total of Column 4}}{100} = 2.75$$

SIEVE ANALYSIS OF FINE AND COARSE AGGREGATE

Test Method Evaluated: AASHTO T27 PTM 616 ASTM C136	
Person to be Evaluated	
Date the test method was read and understood	
Evaluator	
Date Evaluated	
Next Evaluation Date	

PROCEDURE

Fine Aggregate

1. Obtain sample by AASHTO T248 (ASTM C702)…………………………..…………………………………….....
2. Minimum sample weight is 500 g…………………………………………………………….……………………
3. Was AASHTO T11 (ASTM C117) used *(optional)* ....Yes No
   If so, use a No.200 sieve in the dry nest....……………………………..……..……………….…………………….
4. Dry sample to constant weight at 110º _ 5º C (230º _ 9º F)……………………...……………………….……………….….
5. Inspect all sieves before testing, sieves should be clean and free of rips………………………..……………………...
6. *AASHTO*: Determine mass to nearest 0.1% of the original dry sample mass……………………………………………...
   NOTE: If the specimen consists of material left over after AASHTO T11, step 5 does not apply because the total sample mass was determined as part of that test.
7. (a) *AASHTO and PTM*: Continue sieving until no more than 0.5% by weight of the total sample passes a given sieve in 1 minute of continuous hand sieving……………………………………………..…………………………………....
   (b) A*STM*: Continue sieving until no more than one per cent by mass of the residue passes a given sieve in 1 minute of continuous hand sieving…………………………………………………………......……………………………….
8. Weigh the residue on each sieve to 0.1% of the original dry sample mass…………………………….………………...
9. Do not overload the sieves, the weight of residue on each sieve (#4 or finer) should not exceed 7 kg/m^2 of sieving surface (200 g for a 8-inch sieve)…………………………………………….……………………
10. The total weight of the sieved sample should agree with the pre-sieved weight to within 0.3% for AASHTO and ASTM and 0.8% for PTM ………………………………………………………………………………………….…....
11. Calculate the percentage retained on each sieve based on the original dry weight, including the material passing the No. 200 sieve……………………………..……………………………………………………....

Coarse Aggregate and Mixture of Fine and Coarse Aggregate

1. Obtain test sample according to AASHTO T248 (ASTM C702), if the entire field sample is not used…………….…..
2. Dry sample to constant weight at 110º _5º C (230º _ 9º F)……………………………….……….…..…….….…
3. *AASHTO*: Determine mass to nearest 0.1% of the original dry weight…………………………………………………
4. Minimum sample weight will be: #8= 11 lb, #57= 22 lb, #67= 22 lb, #2A = 33 lb per PTM……………………….........
5. If hand sieving do not force particles through the sieve openings…………………………………………………………
6. (a) *AASHTO and PTM*: Continue sieving until no more than 0.5% by weight of the total sample passes a given sieve in 1 minute….……………………………………………………..………………………………………………..
   (b) A*STM*: Continue sieving until no more than one per cent by mass of the residue passes a given sieve in 1 minute of continuous hand sieving…………………………………………………………………………………………......
7. Weigh the residue on each sieve to 0.1% of the original dry weight....…………………………………………………
8. Do not overload the sieves, the weight of residue on each sieve should not exceed 2.5 times the sieve opening in mm times effective sieve area in m^2 (=kg/m^2 of sieving surface area……………………..……………………...……..…..
9. The total weight of the sieved sample should agree with the pre-sieved weight to within 0.3% for AASHTO and ASTM and 0.8% for PTM………………………………………………………………………………………….........
10. Calculate the percentage retained on each sieve based on the original dry weight……………………………….…..
11. Calculate the percentages to the nearest 0.1%, and report to the nearest whole number…………………….……..……

COMMENTS:

LABORATORY TESTING SECTION

Method of Test for

CALIBRATION OF MECHANICAL SIEVE SHAKER

1. SCOPE

1.1 This method of calibration describes a procedure to be used in determining the shaking efficiency of a mechanical sieve shaker.

2. REFERENCED DOCUMENTS

2.1 AASHTO Standards:

2.1.1 R 76, Reducing Samples of Aggregate to Testing Size

2.1.2 T 27, Standard Method of Test for Sieve Analysis of Fine and Coarse Aggregates

2.2 ASTM Standards:

2.2.1 E11, Standard Specification for Woven Wire Test Sieve Cloth and Test Sieves

3. APPARATUS

3.1 Balance- The balance or scale shall conform to the following criteria:

Class	Readability and Sensitivity	Accuracy [a]
G2	0.1 g	0.2 g or 0.1%
G5	1 g	2 g or 0.1%
G20	5 g	5 g or 0.1%
G100	20 g	20 g or 0.1%

[a] Accuracy equal to the mass stated or 0.1% of the test load, whichever is greater, throughout the range of use.

NOTE 1- The balance shall have sufficient capacity to handle the greatest weighing made in conducting the test.

3.2 Sieves- The sieves shall be mounted on substantial frames constructed in a manner that will prevent loss of material during sieving. The sieves shall conform to the requirements of ASTM E11.

3.3 Mechanical Sieve Shaker- A mechanical sieve shaker shall impart a vertical, or lateral and vertical motion to the sieve, causing the particles to bounce and turn so as to present different orientations to the sieving surface.

3.4 Timers- Electric or mechanical timers shall be accurate and variable in 1 minute increments. The timers shall have a capacity of at least 15 minutes.

3.5 Oven- The oven shall be capable of maintaining a uniform temperature of 110 °C ± 5 °C (230F ± 9F).

NOTE 2- Hot plates may be used when test results must be obtained quickly. Confirmation samples shall be tested using ovens as described above.

4. SAMPLES

4.1 A representative sample sufficient to yield not less than the appropriate mass of dry material, as shown below, shall be selected in accordance with AASHTO R 76. The selection of samples of an exact pre-determined mass shall not be attempted.

4.2 After drying, sample fractions of fine aggregate shall have an approximate mass as follows:

Material with a minimum of 95 percent passing the 2.36 mm (No. 8) sieve.. 100 g

Material with a minimum of 85 percent passing the 4.75 mm (No. 4) sieve, and more than 5 percent retained on a 2.36 (No. 8) sieve.......................... 500 g

NOTE 3- In no case, however, shall the fraction retained on any sieve at the completion of the sieving operation weigh more than 200 g for the usual 203.2 mm (8 inch) diameter sieve. The amount of material retained on the critical sieve may be regulated by the introduction of a larger sieve immediately above the critical sieve or by the selection of a sample of a proper size.

4.3 After drying, samples of coarse aggregate shall have a minimum mass as follows:

AASHTO Number	Minimum Mass of Sample kg	lb.
#3	20	(44)
#5	10	(22)
#57	10	(22)
#67	10	(22)
#7	10	(22)
#8	5	(11)
PA No. 2A	15	(33)

NOTE 4- Samples failing to meet the mass requirements of Sections 4.2 and 4.3 shall be deemed to be insufficient to produce reliable results and shall not be tested. However, the intent of this method will be satisfied for samples of aggregate larger than 50 mm (2 inches) nominal maximum size if a smaller mass of a sample is used, provided the criterion for acceptance or rejection of the material is based on the average of the results of at least three samples. The sample size used times the number of samples averaged shall equal the minimum mass of the sample shown in Section 4.3. The differences in individual sample sizes shall not vary by mass by more than 20 percent from each other.

5. PROCEDURE

5.1 Coarse Aggregate

5.1.1 This procedure is to be used for each aggregate size produced. After obtaining a representative sample, shake the particular material at least one minute less than the time currently being used on the mechanical sieve shaker for a given aggregate size.

5.1.2 Weigh and record the amount retained on each individual sieve. Return the amount retained onto each one of the individual sieves where there is a significant amount of material retained. Typically, these are the middle sieves of the gradation.

5.1.3 Place the first sieve that has a significant amount of material retained on the sieve mesh into the shaking device. Shake for an additional minute. Weigh and record the amount retained on this sieve after one minute of additional mechanical shaking. Follow the same procedure for the remaining individual sieves that have been determined to have a significant amount of material retained.

5.1.4 Calculation to Determine Shaking Efficiency:

$$P = \frac{W_o - W_a}{W_t} \times 100$$

Where:

P = Percentage difference of weight retained on the individual sieve

W_o = Original weight retained on the individual sieve

W_a = Weight retained on the individual sieve after additional sieving

W_t = Total sample weight, dry

5.1.5 When the difference between the weights retained on each individual sieve after additional mechanical sieving and the original sieving is 0.5 %, or less, of the total oven dry sample weight, **FOR ALL SIEVE SIZES**, the shaking time used in Section 5.1.1 is sufficient. If any of the differences calculated are greater than 0.5 % of the total oven dry sample weight, repeat this process outlined above with a new representative sample. Increase the mechanical shaking time by one minute. Repeat the process as many times as necessary, but do not exceed 12 minutes of shaking time for any aggregate on any shaking device. If the shaking device cannot meet this requirement, replace or repair the shaking device.

5.1.6 Example of a Shaking Efficiency Determination:

No. 57 Coarse Aggregate
Total Dry Sample Weight = 30.00 lbs

Sieve	Weight Retained After 7 Minutes of Mechanical Shaking, lbs.	Weight Retained After 1 Minute of Additional Mechanical Shaking, lbs.
5/8 in	6.20	6.10
1/2 in.	12.10	12.00
3/8 in.	4.10	4.00

Calculation to Determine Shaking Efficiency

5/8 in.	6.20 lbs – 6.10 lbs = 0.10 lbs ÷ 30.00 lbs x 100 = 0.3 % difference
1/2 in.	12.10 lbs – 12.00 lbs = 0.10 lbs ÷ 30.00 lbs x 100 = 0.3 % difference
3/8 in.	4.10 lbs – 4.00 lbs = 0.10 lbs ÷ 30.00 lbs x 100 = 0.3 % difference

The results of this calculation to determine shaking efficiency for each of the three sieves indicate that all three sieves meet the 0.5% requirement stated in Section 5.1.5. In this example, therefore, a mechanical shaking time of 7 minutes is sufficient for this #57 coarse aggregate material on this shaking device.

5.2 Fine Aggregate

5.2.1 This procedure is to be used for each aggregate size produced. Retain the fine aggregate after the wash test and mechanically shake for at least 1 minute less than the time currently being used on the mechanical sieve shaker for a given aggregate size.

NOTE 5- Washing the sample before performing the shaking efficiency determination is not necessary for bituminous sands and Type 1, 1A, 2, 3, 3A, and 4 anti-skids.

5.2.2 Weigh and record the amount retained on each individual sieve. Return the amount retained onto each one of the individual sieves where there is a significant amount of material retained. Typically, these are the middle sieves of the gradation.

5.2.3 Hand sieve each individual sieve size in accordance with AASHTO T 27, Section 8.4 stated as follows: Hold the individual sieve, provided with a snug-fitting pan and cover, in a slightly inclined position in one hand. Strike the side of the sieve sharply and with an upward motion against the heel of the other hand at a rate of about 150 times per minute, turning the sieve about one-sixth of a revolution at intervals of about 25 strokes. Weigh and record the amount retained on each individual sieve after one minute of additional hand shaking.

5.2.4 Calculation to Determine Shaking Efficiency:

$$P = \frac{W_o - W_a}{W_t} \times 100$$

Where:

P = Percentage difference of weight retained on the individual sieve

W_o = Original weight retained on the individual sieve

W_a = Weight retained on the individual sieve after additional sieving

W_t = Total sample weight, dry

5.2.5 When the difference between the weight retained on each individual sieve after additional hand sieving and the original sieving is 0.5 %, or less, of the total oven dry sample weight, **FOR ALL SIEVE SIZES**, the shaking time used in Section 5.2.1 is sufficient. If any of the sieves have differences calculated that are greater than 0.5 % of the total oven dry sample weight, repeat this process outlined above with a new representative sample. Increase the mechanical shaking time by one minute. Repeat the process as many times as necessary, but do not exceed 12 minutes of shaking time for any aggregate on any shaking device. If the shaking device cannot meet this requirement, replace or repair the shaking device.

5.2.6 Example of a Shaking Efficiency Determination:

Type A Concrete Sand
Total dry sample weight = 490.0 grams

Sieve	Weight Retained After 7 Minutes of Mechanical Shaking, lbs.	Weight Retained After 1 Minute of Additional Mechanical Shaking, lbs.
No. 8	120.0	115.0
No. 16	140.0	138.0
No. 30	100.0	98.0

Calculation to Determine Shaking Efficiency

No. 8	120.0 g – 115.0 g = 5.0 g ÷ 490 g x 100 = 1.0 % difference
No. 16	140.0 g – 138.0 g = 2.0 g ÷ 490 g x 100 = 0.4 % difference
No. 30	100.0 g – 98.0 g = 2.0 g ÷ 490 g x 100 = 0.4 % difference

Although the No. 16 and the No. 30 sieves met the requirement of 0.5 % for this material, the No. 8 sieve did not. Therefore, increase the shaking time for this material to 8 minutes and repeat the process with another new representative sample.

6. REFERENCES

6.1 Pennsylvania Test Method:

6.1.1 PTM No. 616, Method of Test for Sieve Analysis of Coarse and Fine Aggregate

Type A Fine Aggregate Examples

TA Concrete Sand Example #1			
Wash test			
Original Wt.	550.7		
Final Wt.	547.2		
Loss			
% Loss			
Screen	Scale Reading	With Wash	Total % Pass
3/8"	547.2		
#4	530.3		
#8	462.9		
#16	380.2		
#30	311.5		
#50	132.2		
#100	57.6		
F.M.			

TA Concrete Sand Example #2			
Wash test			
Original Wt.	515.6		
Final Wt.	507.8		
Loss			
% Loss			
Screen	Scale Reading	With Wash	Total % Pass
3/8"	507.8		
#4	500.2		
#8	420.7		
#16	320.6		
#30	289.7		
#50	101.4		
#100	35.2		
F.M.			

TA Concrete Sand Example #3			
Wash test			
Original Wt.	510.5		
Final Wt.	501.4		
Loss			
% Loss			
Screen	Scale Reading	With Wash	Total % Pass
3/8"	501.4		
#4	496.5		
#8	400.6		
#16	296.4		
#30	242.5		
#50	100.2		
#100	30.5		
F.M.			

TA Concrete Sand Example #4			
Wash test			
Original Wt.	500.2		
Final Wt.	489.2		
Loss			
% Loss			
Screen	Scale Reading	With Wash	Total % Pass
3/8"	489.2		
#4	450.6		
#8	389.7		
#16	300.1		
#30	287.5		
#50	96.4		
#100	30.4		
F.M.			

TA Concrete Sand Example #5			
Wash test			
Original Wt.	520.6		
Final Wt.	505.3		
Loss			
% Loss			
Screen	Scale Reading	With Wash	Total % Pass
3/8"	505.3		
#4	450.6		
#8	350.8		
#16	300.4		
#30	275.3		
#50	105.8		
#100	32.5		
F.M.			

TA Concrete Sand Example #6			
Wash test			
Original Wt.	526.7		
Final Wt.	520.7		
Loss			
% Loss			
Screen	Scale Reading	With Wash	Total % Pass
3/8"	520.7		
#4	507.4		
#8	440.6		
#16	375.4		
#30	300.6		
#50	119.8		
#100	45.8		
F.M.			

Type A Fine Aggregate Answers

TA Concrete Sand Example #1			
Wash test			
Original Wt.	550.7		
Final Wt.	547.2		
Loss	3.5		
% Loss	0.64		
Screen	Scale Reading	With Wash	Total % Pass
3/8"	547.2	550.7	100
#4	530.3	533.8	97
#8	462.9	466.4	85
#16	380.2	383.7	70
#30	311.5	315.0	57
#50	132.2	135.7	25
#100	57.6	61.1	11
F.M.	2.55		

TA Concrete Sand Example #2			
Wash test			
Original Wt.	515.6		
Final Wt.	507.8		
Loss	7.8		
% Loss	1.51		
Screen	Scale Reading	With Wash	Total % Pass
3/8"	507.8	515.6	100
#4	500.2	508.0	99
#8	420.7	428.5	83
#16	320.6	328.4	64
#30	289.7	297.5	58
#50	101.4	109.2	21
#100	35.2	43.0	8
F.M.	2.67		

TA Concrete Sand Example #3			
Wash test			
Original Wt.	510.5		
Final Wt.	501.4		
Loss	9.1		
% Loss	1.78		
Screen	Scale Reading	With Wash	Total % Pass
3/8"	501.4	510.5	100
#4	496.5	505.6	99
#8	400.6	409.7	80
#16	296.4	305.5	60
#30	242.5	251.6	49
#50	100.2	109.3	21
#100	30.5	39.6	8
F.M.	2.83		

TA Concrete Sand Example #4			
Wash test			
Original Wt.	500.2		
Final Wt.	489.2		
Loss	11.0		
% Loss	2.20		
Screen	Scale Reading	With Wash	Total % Pass
3/8"	489.2	500.2	100
#4	450.6	461.6	92
#8	389.7	400.7	80
#16	300.1	311.1	62
#30	287.5	298.5	60
#50	96.4	107.4	21
#100	30.4	41.4	8
F.M.	2.77		

TA Concrete Sand Example #5			
Wash test			
Original Wt.	520.6		
Final Wt.	505.3		
Loss	15.3		
% Loss	2.94		
Screen	Scale Reading	With Wash	Total % Pass
3/8"	505.3	520.6	100
#4	450.6	465.9	89
#8	350.8	366.1	70
#16	300.4	315.7	61
#30	275.3	290.6	56
#50	105.8	121.1	23
#100	32.5	47.8	9
F.M.	2.92		

TA Concrete Sand Example #6			
Wash test			
Original Wt.	526.7		
Final Wt.	520.7		
Loss	6.0		
% Loss	1.14		
Screen	Scale Reading	With Wash	Total % Pass
3/8"	520.7	526.7	100
#4	507.4	513.4	97
#8	440.6	446.6	85
#16	375.4	381.4	72
#30	300.6	306.6	58
#50	119.8	125.8	24
#100	45.8	51.8	10
F.M.	2.54		

AASHTO No. 8 Examples

AASHTO No. 8 Example #1		
Original Wt.	12.65	
Screen	Mass Passing	Total % Pass
1/2"	12.65	
3/8"	11.08	
1/4"	3.91	
#4	1.20	
#8	0.24	
#16	0.16	

AASHTO No. 8 Example #2		
Original Wt.	12.04	
Screen	Mass Passing	Total % Pass
1/2"	12.04	
3/8"	11.13	
1/4"	6.49	
#4	3.52	
#8	0.63	
#16	0.29	

AASHTO No. 8 Example #3		
Original Wt.	12.11	
Screen	Mass Passing	Total % Pass
1/2"	12.11	
3/8"	11.31	
1/4"	6.87	
#4	3.81	
#8	0.68	
#16	0.30	

AASHTO No. 8 Example #4		
Original Wt.	13.35	
Screen	Mass Passing	Total % Pass
1/2"	13.35	
3/8"	11.79	
1/4"	4.22	
#4	1.32	
#8	0.28	
#16	0.18	

AASHTO No. 8 Example #5		
Original Wt.	13.23	
Screen	Mass Passing	Total % Pass
1/2"	13.23	
3/8"	11.78	
1/4"	5.33	
#4	2.09	
#8	0.56	
#16	0.31	

AASHTO No. 8 Example #6		
Original Wt.	12.04	
Screen	Mass Passing	Total % Pass
1/2"	12.04	
3/8"	11.33	
1/4"	6.90	
#4	3.89	
#8	0.79	
#16	0.35	

AASHTO No. 8 Answers

AASHTO No. 8 Example #1		
Original Wt.	12.65	
Screen	Mass Passing	Total % Pass
1/2"	12.65	100
3/8"	11.08	88
1/4"	3.91	31
#4	1.20	9
#8	0.24	2
#16	0.16	1

AASHTO No. 8 Example #2		
Original Wt.	12.04	
Screen	Mass Passing	Total % Pass
1/2"	12.04	100
3/8"	11.13	92
1/4"	6.49	54
#4	3.52	29
#8	0.63	5
#16	0.29	2

AASHTO No. 8 Example #3		
Original Wt.	12.11	
Screen	Mass Passing	Total % Pass
1/2"	12.11	100
3/8"	11.31	93
1/4"	6.87	57
#4	3.81	31
#8	0.68	6
#16	0.30	2

AASHTO No. 8 Example #4		
Original Wt.	13.35	
Screen	Mass Passing	Total % Pass
1/2"	13.35	100
3/8"	11.79	88
1/4"	4.22	32
#4	1.32	10
#8	0.28	2
#16	0.18	1

AASHTO No. 8 Example #5		
Original Wt.	13.23	
Screen	Mass Passing	Total % Pass
1/2"	13.23	100
3/8"	11.78	89
1/4"	5.33	40
#4	2.09	16
#8	0.56	4
#16	0.31	2

AASHTO No. 8 Example #6		
Original Wt.	12.04	
Screen	Mass Passing	Total % Pass
1/2"	12.04	100
3/8"	11.33	94
1/4"	6.90	57
#4	3.89	32
#8	0.79	7
#16	0.35	3

AASHTO No. 57 Examples

AASHTO No. 57 Example #1		
Original Wt.	26.02	
Screen	Mass Passing	Total % Pass
1 1/2"	26.02	
1"	25.93	
5/8"	15.21	
1/2"	9.41	
3/8"	5.10	
#4	1.26	
#8	0.68	

AASHTO No. 57 Example #2		
Original Wt.	25.37	
Screen	Mass Passing	Total % Pass
1 1/2"	25.37	
1"	24.10	
5/8"	11.67	
1/2"	5.88	
3/8"	2.17	
#4	0.40	
#8	0.26	

AASHTO No. 57 Example #3		
Original Wt.	24.43	
Screen	Mass Passing	Total % Pass
1 1/2"	24.43	
1"	22.60	
5/8"	13.57	
1/2"	8.34	
3/8"	3.61	
#4	0.46	
#8	0.27	

AASHTO No. 57 Example #4		
Original Wt.	25.30	
Screen	Mass Passing	Total % Pass
1 1/2"	25.30	
1"	25.17	
5/8"	13.95	
1/2"	7.67	
3/8"	3.63	
#4	1.00	
#8	0.70	

AASHTO No. 57 Example #5		
Original Wt.	25.09	
Screen	Mass Passing	Total % Pass
1 1/2"	25.09	
1"	24.87	
5/8"	13.77	
1/2"	8.04	
3/8"	4.28	
#4	1.10	
#8	0.77	

AASHTO No. 57 Example #6		
Original Wt.	25.32	
Screen	Mass Passing	Total % Pass
1 1/2"	25.32	
1"	23.96	
5/8"	15.63	
1/2"	9.81	
3/8"	4.84	
#4	0.54	
#8	0.29	

AASHTO No. 57 Answers

AASHTO No. 57 Example #1		
Original Wt.	26.02	
Screen	Mass Passing	Total % Pass
1 1/2"	26.02	100
1"	25.93	100
5/8"	15.21	58
1/2"	9.41	36
3/8"	5.10	20
#4	1.26	5
#8	0.68	3

AASHTO No. 57 Example #2		
Original Wt.	25.37	
Screen	Mass Passing	Total % Pass
1 1/2"	25.37	100
1"	24.10	95
5/8"	11.67	46
1/2"	5.88	23
3/8"	2.17	9
#4	0.40	2
#8	0.26	1

AASHTO No. 57 Example #3		
Original Wt.	24.43	
Screen	Mass Passing	Total % Pass
1 1/2"	24.43	100
1"	22.60	93
5/8"	13.57	56
1/2"	8.34	34
3/8"	3.61	15
#4	0.46	2
#8	0.27	1

AASHTO No. 57 Example #4		
Original Wt.	25.30	
Screen	Mass Passing	Total % Pass
1 1/2"	25.30	100
1"	25.17	99
5/8"	13.95	55
1/2"	7.67	30
3/8"	3.63	14
#4	1.00	4
#8	0.70	3

AASHTO No. 57 Example #5		
Original Wt.	25.09	
Screen	Mass Passing	Total % Pass
1 1/2"	25.09	100
1"	24.87	99
5/8"	13.77	55
1/2"	8.04	32
3/8"	4.28	17
#4	1.10	4
#8	0.77	3

AASHTO No. 57 Example #6		
Original Wt.	25.32	
Screen	Mass Passing	Total % Pass
1 1/2"	25.32	100
1"	23.96	95
5/8"	15.63	62
1/2"	9.81	39
3/8"	4.84	19
#4	0.54	2
#8	0.29	1

PennDOT No. 2A Examples

PennDOT No. 2A Example #1		
Original Wt.	32.20	
Screen	Mass Passing	Total % Pass
1 1/2"	32.2	
1"	30.7	
3/4"	22.3	
1/2"	14.6	
3/8"	11.1	
#4	7.6	
Mass Split for Fine Gradation	520.6	
K Factor		
Screen	Mass Passing	Total % Pass
#4	520.6	
#8	367.8	
#16	296.5	

PennDOT No. 2A Example #2		
Original Wt.	35.60	
Screen	Mass Passing	Total % Pass
1 1/2"	35.6	
1"	32.9	
3/4"	22.5	
1/2"	15.6	
3/8"	10.2	
#4	8.8	
Mass Split for Fine Gradation	500.0	
K Factor		
Screen	Mass Passing	Total % Pass
#4	500.0	
#8	350.4	
#16	286.3	

PennDOT No. 2A Example #3		
Original Wt.	30.50	
Screen	Mass Passing	Total % Pass
1 1/2"	30.5	
1"	28.6	
3/4"	20.5	
1/2"	13.6	
3/8"	10.5	
#4	9.6	
Mass Split for Fine Gradation	525.2	
K Factor		
Screen	Mass Passing	Total % Pass
#4	525.2	
#8	350.8	
#16	276.5	

PennDOT No. 2A Example #4		
Original Wt.	38.50	
Screen	Mass Passing	Total % Pass
1 1/2"	38.5	
1"	32.6	
3/4"	29.3	
1/2"	19.9	
3/8"	12.5	
#4	10.2	
Mass Split for Fine Gradation	503.4	
K Factor		
Screen	Mass Passing	Total % Pass
#4	503.4	
#8	330.6	
#16	259.4	

PennDOT No. 2A Answers

PennDOT No. 2A Example #1		
Original Wt.	32.20	
Screen	Mass Passing	Total % Pass
1 1/2"	32.2	100
1"	30.7	95
3/4"	22.3	69
1/2"	14.6	45
3/8"	11.1	34
#4	7.6	24
Mass Split for Fine Gradation	520.6	
K Factor	0.046	
Screen	Mass Passing	Total % Pass
#4	520.6	24
#8	367.8	17
#16	296.5	14

PennDOT No. 2A Example #2		
Original Wt.	35.60	
Screen	Mass Passing	Total % Pass
1 1/2"	35.6	100
1"	32.9	92
3/4"	22.5	63
1/2"	15.6	44
3/8"	10.2	29
#4	8.8	25
Mass Split for Fine Gradation	500.0	
K Factor	0.050	
Screen	Mass Passing	Total % Pass
#4	500.0	25
#8	350.4	18
#16	286.3	14

PennDOT No. 2A Example #3		
Original Wt.	30.50	
Screen	Mass Passing	Total % Pass
1 1/2"	30.5	100
1"	28.6	94
3/4"	20.5	67
1/2"	13.6	45
3/8"	10.5	34
#4	9.6	31
Mass Split for Fine Gradation	525.2	
K Factor	0.059	
Screen	Mass Passing	Total % Pass
#4	525.2	31
#8	350.8	21
#16	276.5	16

PennDOT No. 2A Example #4		
Original Wt.	38.50	
Screen	Mass Passing	Total % Pass
1 1/2"	38.5	100
1"	32.6	85
3/4"	29.3	76
1/2"	19.9	52
3/8"	12.5	32
#4	10.2	26
Mass Split for Fine Gradation	503.4	
K Factor	0.052	
Screen	Mass Passing	Total % Pass
#4	503.4	26
#8	330.6	17
#16	259.4	13

STANDARD DEVIATION: Sample Problems

Standard Deviation Sample Problem 1

___5___ + ___7___ + ___10___ + ___3___ ÷ _______ = _______ (Average)
(Sample #1) (Sample #2) (Sample #3) (Sample #4)

(Sample #1) - (Average) = _____________ x^2 = ______________ (A)
(Sample #2) - (Average) = _____________ x^2 = ______________ (B)
(Sample #3) - (Average) = _____________ x^2 = ______________ (C)
(Sample #4) - (Average) = _____________ x^2 = ______________ (D)

_____________ + _____________ + _____________ + _____________ ÷ _______ = _______ (E)
(A) (B) (C) (D) (n-1)

$\sqrt{(EE)}$ = _____________ (Standard Deviation)

Standard Deviation Sample Problem 2

___1.69___ + ___1.87___ + ___1.53___ + ___1.72___ + ___1.59___ ÷ ___ = _______ (Average)
(Sample #1) (Sample #2) (Sample #3) (Sample #4) (Sample #5)

(Sample #1) - (Average) = _____________ x^2 = ______________ (A)
(Sample #2) - (Average) = _____________ x^2 = ______________ (B)
(Sample #3) - (Average) = _____________ x^2 = ______________ (C)
(Sample #4) - (Average) = _____________ x^2 = ______________ (D)
(Sample #5) - (Average) = _____________ x^2 = ______________ (E)

_____________ + _____________ + _____________ + _____________ + _____________ ÷ _____ = __________ (F)
(A) (B) (C) (D) (E) (n-1)

$\sqrt{(F)}$ = _____________ (Standard Deviation)

Standard Deviation Sample Problem 3

13	+	21	+	10	÷	______	=	______	(Average)
(Sample #1)		(Sample #2)		(Sample #3)					

(Sample #1) - (Average) = __________ x^2 = __________ (A) x^2

(Sample #2) - (Average) = __________ = __________ (B) x^2

(Sample #3) - (Average) = __________ = __________ (C)

______	+	______	+	______	÷	______	=	______	(D)
(A)		(B)		(C)		(n-1)			

$\sqrt{(DD)}$ = __________ (Standard Deviation)

Standard Deviation Sample Problem 4

100	+	113	+	98	+	103	+	95	÷	___	=	______	(Average)
(Sample #1)		(Sample #2)		(Sample #3)		(Sample #4)		(Sample #5)					

(Sample #1) - (Average) = __________ x^2 = __________ (A)

(Sample #2) - (Average) = __________ x^2 = __________ (B)

(Sample #3) - (Average) = __________ x^2 = __________ (C)

(Sample #4) - (Average) = __________ x^2 = __________ (D)

(Sample #5) - (Average) = __________ x^2 = __________ (E)

______	+	______	+	______	+	______	+	______	÷	______	=	______	(F)
(A)		(B)		(C)		(D)		(E)		(n-1)			

$\sqrt{(FF)}$ = __________ (Standard Deviation)

Standard Deviation Sample Problem 5

_____3_____+_____7_____+_____5_____÷__________=______(Average)
(Sample #1) (Sample #2) (Sample #3)

(Sample #1) - (Average) = ____________ x^2 = __________(A) x^2
(Sample #2) - (Average) = ____________ = __________(B) x^2
(Sample #3) - (Average) = ____________ = __________(C)

__________ + __________ + __________ ÷ __________ = ______ (D)
(A) (B) (C) (n-1)

$\sqrt{(DD)}$ = __________(Standard Deviation)

Standard Deviation Sample Problem 6

____1.26____+____1.57____+____1.98____+____0.96____÷______=______(Average)
(Sample #1) (Sample #2) (Sample #3) (Sample #4)

(Sample #1) - (Average) = __________ x^2 = __________ (A)
(Sample #2) - (Average) = __________ x^2 = __________ (B)
(Sample #3) - (Average) = __________ x^2 = __________ (C)
(Sample #4) - (Average) = __________ x^2 = __________ (D)

__________ + __________ + __________ + __________ ÷ ______ = ______ (E)
(A) (B) (C) (D) (n-1)

$\sqrt{(EE)}$ = __________(Standard Deviation)

Standard Deviation Sample Problem 7

0.50 (Sample #1) + 0.90 (Sample #2) + 0.40 (Sample #3) ÷ ______ = ______ (Average)

(Sample #1) - (Average) = ______ x^2 = ______ (A) x^2

(Sample #2) - (Average) = ______ = ______ (B) x^2

(Sample #3) - (Average) = ______ = ______ (C)

______ (A) + ______ (B) + ______ (C) ÷ ______ (n-1) = ______ (D)

$\sqrt{(DD)}$ = ______ (Standard Deviation)

Standard Deviation Sample Problem 8

5.5 (Sample #1) + 3.6 (Sample #2) + 7.4 (Sample #3) + 8.1 (Sample #4) + 4.9 (Sample #5) ÷ ___ = ______ (Average)

(Sample #1) - (Average) = ______ x^2 = ______ (A)

(Sample #2) - (Average) = ______ x^2 = ______ (B)

(Sample #3) - (Average) = ______ x^2 = ______ (C)

(Sample #4) - (Average) = ______ x^2 = ______ (D)

(Sample #5) - (Average) = ______ x^2 = ______ (E)

______ (A) + ______ (B) + ______ (C) + ______ (D) + ______ (E) ÷ ______ (n-1) = ______ (F)

$\sqrt{(FF)}$ = ______ (Standard Deviation)

STANDARD DEVIATION: Sample Answers

Standard Deviation Sample Problem 1

5	+	7	+	10	+	3	÷	4	=	6	(Average)
(Sample #1)		(Sample #2)		(Sample #3)		(Sample #4)					

(Sample #1)	-	(Average)	=	-1	x^2	=	1	(A)
(Sample #2)	-	(Average)	=	1	x^2	=	1	(B)
(Sample #3)	-	(Average)	=	4	x^2	=	16	(C)
(Sample #4)	-	(Average)	=	-3	x^2	=	9	(D)

1	+	1	+	16	+	9	÷	3	=	9	(E)
(A)		(B)		(C)		(D)		(n-1)			

$\sqrt{(EE)}$ = 3.0 (Standard Deviation)

Standard Deviation Sample Problem 2

1.69	+	1.87	+	1.53	+	1.72	+	1.59	÷	5	=	1.68	(Average)
(Sample #1)		(Sample #2)		(Sample #3)		(Sample #4)		(Sample #5)					

(Sample #1)	-	(Average)	=	0.01	x^2	=	0.0001	(A)
(Sample #2)	-	(Average)	=	0.19	x^2	=	0.0361	(B)
(Sample #3)	-	(Average)	=	-0.15	x^2	=	0.0225	(C)
(Sample #4)	-	(Average)	=	0.04	x^2	=	0.0016	(D)
(Sample #5)	-	(Average)	=	-0.09	x^2	=	0.0081	(E)

0.0001	+	0.0361	+	0.0225	+	0.0016	+	0.0081	÷	4	=	0.0171	(F)
(A)		(B)		(C)		(D)		(E)		(n-1)			

$\sqrt{(FF)}$ = 0.13 (Standard Deviation)

Standard Deviation Sample Problem 3

13	+	21	+	10	÷	3	= 15 (Average)
(Sample #1)		(Sample #2)		(Sample #3)			

(Sample #1)	-	(Average)	= -2	x^2	= 4	(A)
(Sample #2)	-	(Average)	= 6	x^2	= 36	(B)
(Sample #3)	-	(Average)	= -5	x^2	= 25	(C)

4	+	36	+	25	÷	2	= 33	(D)
(A)		(B)		(C)		(n-1)		

$\sqrt{(DD)}$ = 5.7 (Standard Deviation)

Standard Deviation Sample Problem 4

100	+	113	+	98	+	103	+	95	÷	5	= 102 (Average)
(Sample #1)		(Sample #2)		(Sample #3)		(Sample #4)		(Sample #5)			

(Sample #1)	-	(Average)	= -2	x^2	= 4	(A)
(Sample #2)	-	(Average)	= 11	x^2	= 121	(B)
(Sample #3)	-	(Average)	= -4	x^2	= 16	(C)
(Sample #4)	-	(Average)	= 1	x^2	= 1	(D)
(Sample #5)	-	(Average)	= -7	x^2	= 49	(E)

4	+	121	+	16	+	1	+	49	÷	4	=	48 (F)
(A)		(B)		(C)		(D)		(E)		(n-1)		

$\sqrt{(FF)}$ = 6.9 (Standard Deviation)

Standard Deviation Sample Problem 5

3	+	7	+	5	÷	3	=	5	(Average)
(Sample #1)		(Sample #2)		(Sample #3)					

(Sample #1)	-	(Average)	=	-2	x^2	=	4	(A)
(Sample #2)	-	(Average)	=	2	x^2	=	4	(B)
(Sample #3)	-	(Average)	=	0	x^2	=	0	(C)

4	+	4	+	0	÷	2	=	4	(D)
(A)		(B)		(C)		(n-1)			

$\sqrt{(DD)}$ = 2.0 (Standard Deviation)

Standard Deviation Sample Problem 6

1.26	+	1.57	+	1.98	+	0.96	÷	4	=	1.44	(Average)
(Sample #1)		(Sample #2)		(Sample #3)		(Sample #4)					

(Sample #1)	-	(Average)	=	-0.18	x^2	=	0.03	(A)
(Sample #2)	-	(Average)	=	0.13	x^2	=	0.02	(B)
(Sample #3)	-	(Average)	=	0.54	x^2	=	0.29	(C)
(Sample #4)	-	(Average)	=	-0.48	x^2	=	0.23	(D)

0.03	+	0.02	+	0.29	+	0.23	÷	3	=	0.19	(E)
(A)		(B)		(C)		(D)		(n-1)			

$\sqrt{(EE)}$ = 0.44 (Standard Deviation)

Standard Deviation Sample Problem 7

0.50	+	0.90	+	0.40	÷	3	=	0.60	(Average)
(Sample #1)		(Sample #2)		(Sample #3)					

(Sample #1)	-	(Average)	=	-0.10	x^2	=	0.01	(A)
(Sample #2)	-	(Average)	=	0.30	x^2	=	0.09	(B)
(Sample #3)	-	(Average)	=	-0.20	x^2	=	0.04	(C)

0.01	+	0.09	+	0.04	÷	2	=	0.07	(D)
(A)		(B)		(C)		(n-1)			

$\sqrt{(DD)}$ = 0.26 (Standard Deviation)

Standard Deviation Sample Problem 8

5.5	+	3.6	+	7.4	+	8.1	+	4.9	÷	5	=	5.9	(Average)
(Sample #1)		(Sample #2)		(Sample #3)		(Sample #4)		(Sample #5)					

(Sample #1)	-	(Average)	=	-0.4	x^2	=	0.2	(A)
(Sample #2)	-	(Average)	=	-2.3	x^2	=	5.3	(B)
(Sample #3)	-	(Average)	=	1.5	x^2	=	2.3	(C)
(Sample #4)	-	(Average)	=	2.2	x^2	=	4.8	(D)
(Sample #5)	-	(Average)	=	-1.0	x^2	=	1.0	(E)

0.2	+	5.3	+	2.3	+	4.8	+	1.0	÷	4	=	3.4	(F)
(A)		(B)		(C)		(D)		(E)		(n-1)			

$\sqrt{(FF)}$ = 1.8 (Standard Deviation)

PWL: SAMPLE PROBLEMS

PWL Sample Problem 1

						Limits				
Screen	*Inc #1*	*Inc #2*	*Inc #3*	*Avg*	*Std. Dev.*	*L*	*U*	*Q U*	*Q L*	*PWT*
1 1/2"	100	100	100	100	0	100	100			100
1"	95	97	97	96	1.2	95	100			100
1/2"	**25**	**23**	**24**			**25**	**60**			
#4	9	7	8	8	1	0	10			100
#8	4	3	3	3	0.6	0	5			100
#200	1.2	1.1	1.2	1.17	0.06	0	1.49			100
									Total Sample PWL Based on Construction Specifications	

$Q_L = \frac{(\text{Avg - L})}{\text{Std. Dev}}$ $Q_L = \frac{(\text{? - 25})}{\text{?}}$ $Q_L =$

PWL Sample Problem 2

						Limits				
Screen	*Inc #1*	*Inc #2*	*Inc #3*	*Avg*	*Std. Dev.*	*L*	*U*	*Q U*	*Q L*	*PWT*
1 1/2"	100	100	100	100	0	100	100			100
1"	96	96	96	96	0	95	100			100
1/2"	**63**	**61**	**59**			**25**	**60**			
#4	1	2	2	2	0.6	0	10			100
#8	1	1	1	1	0	0	5			100
#200	1.2	1.1	1.2	1.17	0.06	0	1.49			100
									Total Sample PWL Based on Construction Specifications	

$Q_U = \frac{(\text{U - Avg})}{\text{Std. Dev}}$ $Q_U = \frac{(\text{60 - ?})}{\text{?}}$ $Q_U =$

PWL Sample Problem 3

						Limits				
Screen	*Inc #1*	*Inc #2*	*Inc #3*	*Avg*	*Std. Dev.*	*L*	*U*	*Q U*	*Q L*	*PWT*
1 1/2"	100	100	100	100	0	100	100			100
1"	95	97	97	96	1.2	95	100			100
1/2"	26	27	28	27	1	25	60			100
#4	**12**	**12**	**8**			**0**	**10**			
#8	4	3	3	3	0.6	0	5			100
#200	1.2	1.1	1.2	1.17	0.06	0	1.49			100
									Total Sample PWL Based on Construction Specifications	

Q_U = $\frac{(U - Avg)}{Std. Dev}$ Q_U = $\frac{(10 - ?)}{?}$ Q_U =

PWL Sample Problem 4

						Limits				
Screen	*Inc #1*	*Inc #2*	*Inc #3*	*Avg*	*Std. Dev.*	*L*	*U*	*Q U*	*Q L*	*PWT*
1 1/2"	100	100	100	100	0	100	100			100
1"	**94**	**96**	**93**			**95**	**100**			
1/2"	55	54	54	54	0.6	25	60			100
#4	1	2	2	2	0.6	0	10			100
#8	1	1	1	1	0	0	5			100
#200	1.2	1.1	1.2	1.17	0.06	0	1.49			100
									Total Sample PWL Based on Construction Specifications	

Q_L = $\frac{(Avg - L)}{Std. Dev}$ Q_L = $\frac{(? - 95)}{?}$ Q_L =

PWL Sample Problem 5

						Limits				
Screen	*Inc #1*	*Inc #2*	*Inc #3*	*Avg*	*Std. Dev.*	*L*	*U*	*Q_U*	*Q_L*	*PWT*
1 1/2"	100	100	100	100	0	100	100			100
1"	95	97	97	96	1.2	95	100			100
1/2"	26	27	25	26	1	25	60			100
#4	10	10	9	10	0.6	0	10			100
#8	**6**	**7**	**7**			**0**	**5**			
#200	1.2	1.1	1.2	1.17	0.06	0	1.49			100
									Total Sample PWL Based on Construction Specifications	

$Q_U = \frac{(U - Avg)}{Std. Dev}$ $Q_U = \frac{(5 - ?)}{?}$ $Q_U =$

PWL Sample Problem 6

						Limits				
Screen	*Inc #1*	*Inc #2*	*Inc #3*	*Avg*	*Std. Dev.*	*L*	*U*	*Q_U*	*Q_L*	*PWT*
1 1/2"	100	100	100	100	0	100	100			100
1"	96	96	96	96	0	95	100			100
1/2"	**23**	**19**	**33**			**25**	**60**			
#4	1	2	2	2	0.6	0	10			100
#8	1	1	1	1	0	0	5			100
#200	1.2	1.1	1.2	1.17	0.06	0	1.49			100
									Total Sample PWL Based on Construction Specifications	

$Q_L = \frac{(Avg - L)}{Std. Dev}$ $Q_L = \frac{(? - 25)}{?}$ $Q_L =$

PWL: SAMPLE ANSWERS

PWL Sample Problem 1

						Limits				
Screen	*Inc #1*	*Inc #2*	*Inc #3*	*Avg*	*Std. Dev.*	*L*	*U*	*Q U*	*Q L*	*PWT*
1 1/2"	100	100	100	100	0.0	100	100			100
1"	95	97	97	96	1.2	95	100			100
1/2"	**25**	**23**	**24**	**24**	**1.0**	**25**	**60**		**-1.0000**	**17**
#4	9	7	8	8	1.0	0	10			100
#8	4	3	3	3	0.6	0	5			100
#200	1.2	1.1	1.2	1.17	0.06	0	1.49			100
									Total Sample PWL Based on Construction Specifications	**86**

$$Q_L = \frac{(Avg - L)}{Std. Dev} \qquad Q_L = \frac{(24 - 25)}{1.0} \qquad Q_L = -1.0000$$

PWL Sample Problem 2

						Limits				
Screen	*Inc #1*	*Inc #2*	*Inc #3*	*Avg*	*Std. Dev.*	*L*	*U*	*Q U*	*Q L*	*PWT*
1 1/2"	100	100	100	100	0.0	100	100			100
1"	96	96	96	96	0.0	95	100			100
1/2"	**63**	**61**	**59**	**61**	**2.0**	**25**	**60**	**-0.5000**		**36**
#4	1	2	2	2	0.6	0	10			100
#8	1	1	1	1	0.0	0	5			100
#200	1.2	1.1	1.2	1.17	0.06	0	1.49			100
									Total Sample PWL Based on Construction Specifications	**89**

$$Q_U = \frac{(U - Avg)}{Std. Dev} \qquad Q_U = \frac{(60 - 61)}{2.0} \qquad Q_U = -0.5000$$

PWL Sample Problem 3

						Limits				
Screen	*Inc #1*	*Inc #2*	*Inc #3*	*Avg*	*Std. Dev.*	*L*	*U*	*Q U*	*Q L*	*PWT*
1 1/2"	100	100	100	100	0.0	100	100			100
1"	95	97	97	96	1.2	95	100			100
1/2"	26	27	28	27	1.0	25	60			100
#4	**12**	**12**	**8**	**11**	**2.3**	**0**	**10**	**-0.4348**		**38**
#8	4	3	3	3	0.6	0	5			100
#200	1.2	1.1	1.2	1.17	0.06	0	1.49			100
									Total Sample PWL Based on Construction Specifications	**90**

$$Q_U = \frac{(U - Avg)}{Std.\ Dev} \qquad Q_U = \frac{(10 - 11)}{2.3} \qquad Q_U = -0.4348$$

PWL Sample Problem 4

						Limits				
Screen	*Inc #1*	*Inc #2*	*Inc #3*	*Avg*	*Std. Dev.*	*L*	*U*	*Q U*	*Q L*	*PWT*
1 1/2"	100	100	100	100	0.0	100	100			100
1"	**94**	**96**	**93**	**94**	**1.6**	**95**	**100**		**-0.6250**	**32**
1/2"	55	54	54	54	0.6	25	60			100
#4	1	2	2	2	0.6	0	10			100
#8	1	1	1	1	0.0	0	5			100
#200	1.2	1.1	1.2	1.17	0.06	0	1.49			100
									Total Sample PWL Based on Construction Specifications	**89**

$$Q_L = \frac{(Avg - L)}{Std.\ Dev} \qquad Q_L = \frac{(94 - 95)}{1.6} \qquad Q_L = -0.6250$$

PWL Sample Problem 5

						Limits				
Screen	*Inc #1*	*Inc #2*	*Inc #3*	*Avg*	*Std. Dev.*	*L*	*U*	*Q_U*	*Q_L*	*PWT*
1 1/2"	100	100	100	100	0.0	100	100			100
1"	95	97	97	96	1.2	95	100			100
1/2"	26	27	25	26	1.0	25	60			100
#4	10	10	9	10	0.6	0	10			100
#8	**6**	**7**	**7**	**7**	**0.7**	**0**	**5**	**-2.8571**		**0**
#200	1.2	1.1	1.2	1.17	0.06	0	1.49			100
									Total Sample PWL Based on Construction Specifications	**83**

$Q_U = \frac{(U - Avg)}{Std. Dev}$ $Q_U = \frac{(5 - 7)}{0.7}$ $Q_U = -2.8571$

PWL Sample Problem 6

						Limits				
Screen	*Inc #1*	*Inc #2*	*Inc #3*	*Avg*	*Std. Dev.*	*L*	*U*	*Q_U*	*Q_L*	*PWT*
1 1/2"	100	100	100	100	0.0	100	100			100
1"	96	96	96	96	0.0	95	100			100
1/2"	**23**	**19**	**33**	**25**	**7.2**	**25**	**60**		**0.0000**	**50**
#4	1	2	2	2	0.6	0	10			100
#8	1	1	1	1	0.0	0	5			100
#200	1.2	1.1	1.2	1.17	0.06	0	1.49			100
									Total Sample PWL Based on Construction Specifications	**92**

$Q_L = \frac{(Avg - L)}{Std. Dev}$ $Q_L = \frac{(25 - 25)}{7.2}$ $Q_L = 0.0000$

PWL Worksheet

Find the **Average** of three screens. Fill in the percent passing for each sample, (only for the screen size that failed)

32 (sample #1)	plus	33 (sample #2)	plus	20 (sample #3)	=	85	divided by **3** =	28 (Average) (Round off)

Find the **Standard Deviation** of three screens:

32 (sample #1)	minus	28 (average)	=	4	times itself =	16 (A)
33 (sample #2)	minus	28 (average)	=	5	times itself =	25 (B)
20 (sample #3)	minus	28 (average)	=	-8	times itself =	64 (C)

16 (A)	plus	25 (B)	plus	64 (C)	=	105	divided by **2** =	52.5 (D)

52.5 (D) then press √ (square root button) to find 7.2 (Standard Deviation)

If the failing screen exceeds the UPPER spec limit, then find U.

(upper spec)	minus	(average)	=		divided by	(standard deviation)	= (U)

If the failing screen exceeds LOWER spec limit, then find L.

28 (average)	minus	24 (lower spec)	=	4	divided by	7.2 (standard deviation)	= 0.5555 (L)

Estimated the **Screen PWL** from Table A (Negative numbers) or Table B (Positive numbers) in Pub 408, Section 106.03(a). — 66 (Screen PWL)

Average all the screen size PWL s to find the **Total PWL**.
(For all In Spec screen sizes, PWL = 100) — 94 (Total PWL)

100 100 100 66 100 100 = 566 / 6 = 94

PWL Worksheet

Find the **Average** of three screens. Fill in the percent passing for each sample, (only for the screen size that failed)

______ plus ______ plus ______ = ______ divided by **3** = [(Average) (Round off)]
(sample #1) (sample #2) (sample #3)

Find the **Standard Deviation** of three screens:

______ minus ______ = ______ times itself = [(A)]
(sample #1) (average)

______ minus ______ = ______ times itself = [(B)]
(sample #2) (average)

______ minus ______ = ______ times itself = [(C)]
(sample #3) (average)

______ plus ______ plus ______ = ______ divided by **2** = [(D)]
(A) (B) (C)

______ then press √ (square root button) to find [(Standard Deviation)]
(D)

If the failing screen exceeds the UPPER spec limit, then find U.

______ minus ______ = ______ divided by ______ = [(U)]
(upper spec) (average) (standard deviation)

If the failing screen exceeds LOWER spec limit, then find L.

______ minus ______ = ______ divided by ______ = [(L)]
(average) (lower spec) (standard deviation)

Estimated the **Screen PWL** from Table A (Negative numbers) or Table B (Positive numbers) in Pub 408, Section 106.03(a). [(Screen PWL)]

Average all the screen size PWL s to find the **Total PWL**. [(Total PWL)]
(For all In Spec screen sizes, PWL = 100)

PWL Worksheet

Find the **Average** of three screens. Fill in the percent passing for each sample, (only for the screen size that failed)

______ plus	______ plus	______ =	______ divided by **3** =		(Average)
(sample #1)	(sample #2)	(sample #3)			(Round off)

Find the **Standard Deviation** of three screens:

______ minus ______ = ______ times itself = ______ (A)
(sample #1) (average)

______ minus ______ = ______ times itself = ______ (B)
(sample #2) (average)

______ minus ______ = ______ times itself = ______ (C)
(sample #3) (average)

______ plus ______ plus ______ = ______ divided by **2** = ______ (D)
(A) (B) (C)

______ then press √ (square root button) to find ______ (Standard Deviation)
(D)

If the failing screen exceeds the UPPER spec limit, then find U.

______ minus ______ = ______ divided by ______ = ______ (U)
(upper spec) (average) (standard deviation)

If the failing screen exceeds LOWER spec limit, then find L.

______ minus ______ = ______ divided by ______ = ______ (L)
(average) (lower spec) (standard deviation)

Estimated the **Screen PWL** from Table A (Negative numbers) or Table B (Positive numbers) in Pub 408, Section 106.03(a). ______ (Screen PWL)

Average all the screen size PWL s to find the **Total PWL**.
(For all In Spec screen sizes, PWL = 100) ______ (Total PWL)

TR-4126A (9-08)

aggregate report

pennsylvania
DEPARTMENT OF TRANSPORTATION

❑ Fine aGG. ☒ coaRSe aGG. ❑ anti SKiD	❑ acceptance ❑ VeRiFication ❑ inFoRmation	❑ conStRuction ❑ maintenance	p.o./cont. no
		item numBeR	item quantity
mat'L Spec type #8 - 1%	Date SampLeD ______		

pRoDuceR/Location ______

SyS	SR/po	SpuR	pHa	Sec	DiSt	co	❑ GRaVeL ❑ SLaG ❑ Stone ❑ SanD ❑ coKe ❑ cinDeRS

Lot no. ______
ton(neS) ______ to ______

ton(neS) SHippeD:
toDay ______
to Date ______
BaLance ______

SUBLot No.							SpeC. LIMItS		StatIStICaL aNaLYSIS		
toN(Ne) SaMpLeD											
SIeVe	MaSS (wt)	%	MaSS (wt)	%	MaSS (wt)	%	L	U	$\bar{X}$	S	pwL
100 mm (4")											
90 mm (3 1/2")											
75 mm (3")											
63 mm (2 1/2")											
50 mm (2")											
37.5 mm (1 1/2")											
31.5 mm (1 1/4")											
25.0 mm (1")											
19.0 mm (3/4")											
12.5 mm (1/2")	11.55		11.99		12.53		100	100			
9.5 mm (3/8")	10.28		10.42		11.30		85	100			
8.0 mm (5/16")											
4.75 mm (#4)	2.42		2.49		4.11		10	30			
2.36 mm (#8)	0.29		0.33		0.41		0	10			
1.18 mm (#16)	0.14		0.17		0.26		0	5			
600 µm (#30)											
425 µm (#40)											
300 µm (#50)											
150 µm (#100)											
75 µm (#200)											
MaSS (wt) or FM	11.56		12.02		12.55						

mateRiaL type: ______

teSteD By: ______
SouRce tecH.

WitneSSeD By: ______
Dept. inSpect.

ReVieWeD By:
______
county mGR.
______
D.m. unit
______
DiSt. enGR.

pWL ______
pay ______ %

$\frac{\text{Wet maSS (Wt)} - \text{DRy maSS (Wt)}}{\text{DRy maSS (Wt)}} \times 100$ = % moiStuRe

mat'l finer than 75µm (#200)	1067.4		1243.2		1143.4		0	1.0			
crushed fragments mass (wt) %											
unit weight kg/m³ (lbs/cf)											
coefficient of uniformity											
wet mass (wt)											
dry mass (wt)											

RemaRKS

aVeRaGe = $\bar{X} = \frac{\sum_{i=1}^{n} X_i}{n}$

StanDaRD DeViation $= S = \sqrt{\frac{\sum_{i=1}^{n}(X_i - \bar{X})^2}{n-1}}$

$q_u = \frac{(u - \bar{X})}{S}$ $q_L = \frac{(\bar{X} - L)}{S}$

pWL = $(p_u + p_L) - 100$

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DEPARTMENT OF TRANSPORTATION

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mat'L Spec type #8 - 1%	Date SampLeD ______	item numBeR	item quantity

pRoDuceR/Location ______________________

SyS	SR/po	SpuR	pHa	Sec	DiSt	co

❑ GRaVeL ❑ SanD
❑ SLaG ❑ coKe
❑ Stone ❑ cinDeRS

Lot no.______
ton(neS)______ to ______

ton(neS) SHippeD:
toDay ______
to Date ______
BaLance ______

SUBLot No.							SpeC. LIMItS		StatIStICaL aNaLYSIS		
toN(Ne) SaMpLeD											
SIeVe	MaSS (wt)	%	MaSS (wt)	%	MaSS (wt)	%	L	U	$\overline{X}$	S	pwL
100 mm (4")											
90 mm (3 1/2")											
75 mm (3")											
63 mm (2 1/2")											
50 mm (2")											
37.5 mm (1 1/2")											
31.5 mm (1 1/4")											
25.0 mm (1")											
19.0 mm (3/4")											
12.5 mm (1/2")	11.55	100	11.99	100	12.53	100	100	100	100		
9.5 mm (3/8")	10.28	89	10.42	87	11.30	90	85	100	89		
8.0 mm (5/16")											
4.75 mm (#4)	2.42	21	2.49	21	4.11	33	10	30	25		
2.36 mm (#8)	0.29	3	0.33	3	0.41	3	0	10	3		
1.18 mm (#16)	0.14	1	0.17	1	0.26	2	0	5	1		
600 µm (#30)											
425 µm (#40)											
300 µm (#50)											
150 µm (#100)											
75 µm (#200)											
MaSS (wt) or FM	11.56		12.02		12.55						

mat'l finer than 75µm (#200)	1067.4	1.39	1243.2	1.23	1143.4	1.79	0	1.0	1.47		
crushed fragments mass (wt) %											
unit weight kg/m³ (lbs/cf)											
coefficient of uniformity											
wet mass (wt)											
dry mass (wt)											

mateRiaL type: ______

teSteD By: ______
SouRce tecH.

WitneSSeD By: ______
Dept. inSpect.

ReVieWeD By:
______
county mGR.
______
D.m. unit
______
DiSt. enGR.

pWL ______
pay ______ %

$$\frac{\text{Wet maSS (Wt)} - \text{DRy maSS (Wt)}}{\text{DRy maSS (Wt)}} \times 100 = \%\ \text{moiStuRe}$$

RemaRKS

aVeRaGe $= \overline{X} = \frac{\sum_{i=1}^{n} X_i}{n}$

StanDaRD DeViation $= S = \sqrt{\frac{\sum_{i=1}^{n}(X_i - \overline{X})^2}{n-1}}$

$q_u = \frac{(u - \overline{X})}{S}$ $q_L = \frac{(\overline{X} - L)}{S}$

pWL $= (p_u + p_L) - 100$

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☐ Fine aGG. ☒ coaRSe aGG. ☐ anti SKiD	☐ acceptance ☐ VeRiFication ☐ inFoRmation	☐ conStRuction ☐ maintenance	p.o./cont. no
mat'L Spec type #8 - 1%	Date SampLeD ________	item numBeR	item quantity

pRoDuceR/Location ____________________

SyS	SR/po	SpuR	pHa	Sec	DiSt	co	☐ GRaVeL ☐ SLaG ☐ Stone ☐ SanD ☐ coKe ☐ cinDeRS

Lot no.________
ton(neS)______ to ______
ton(neS) SHippeD:
toDay ________
to Date ________
BaLance ________

SUBLot No.							SpeC. LIMItS		StatIStICaL aNaLYSIS		
toN(Ne) SaMpLeD											
SIeVe	MaSS (wt)	%	MaSS (wt)	%	MaSS (wt)	%	L	U	X̄	S	pwL
100 mm (4")											
90 mm (3 1/2")											
75 mm (3")											
63 mm (2 1/2")											
50 mm (2")											
37.5 mm (1 1/2")											
31.5 mm (1 1/4")											
25.0 mm (1")											
19.0 mm (3/4")											
12.5 mm (1/2")	11.55	100	11.99	100	12.53	100	100	100	100		
9.5 mm (3/8")	10.28	89	10.42	87	11.30	90	85	100	89		
8.0 mm (5/16")											
4.75 mm (#4)	2.42	21	2.49	21	4.11	33	10	30	25		
2.36 mm (#8)	0.29	3	0.33	3	0.41	3	0	10	3		
1.18 mm (#16)	0.14	1	0.17	1	0.26	2	0	5	1		
600 µm (#30)											
425 µm (#40)											
300 µm (#50)											
150 µm (#100)											
75 µm (#200)											
MaSS (wt) or FM	11.56		12.02		12.55						

mateRiaL type: ________

teSteD By: ________ SouRce tecH.

WitneSSeD By: ________ Dept. inSpect.

ReVieWeD By: ________ county mGR. ________ D.m. unit ________ DiSt. enGR.

pWL ________
pay ________ %

$\frac{\text{Wet maSS (Wt)} - \text{DRy maSS (Wt)}}{\text{DRy maSS (Wt)}} \times 100 = \%$ moiStuRe

mat'l finer than 75µm (#200)	1067.4	1.39	1243.2	1.23	1143.4	1.79	0	1.0	1.47		
crushed fragments mass (wt) %											
unit weight kg/m³ (lbs/cf)											
coefficient of uniformity											
wet mass (wt)											
dry mass (wt)											

RemaRKS

aVeRaGe $= \bar{X} = \frac{\sum_{i=1}^{n} X_i}{n}$

StanDaRD DeViation $= S = \sqrt{\frac{\sum_{i=1}^{n}(X_i - \bar{X})^2}{n-1}}$

$q_u = \frac{(u - \bar{X})}{S}$ $\quad q_L = \frac{(\bar{X} - L)}{S}$

$pWL = (p_u + p_L) - 100$

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- [ ] Fine aGG.
- [x] coaRSe aGG.
- [ ] anti SKiD
- [ ] acceptance
- [ ] VeRiFication
- [ ] inFoRmation
- [ ] conStRuction
- [ ] maintenance

p.o./cont. no ____

item numBeR ____

item quantity ____

mat'L Spec type #8 - 1%

Date SampLeD ____

pRoDuceR/Location ____

SyS	SR/po	SpuR	pHa	Sec	DiSt	co

- [ ] GRaVeL
- [ ] SanD
- [ ] SLaG
- [ ] coKe
- [ ] Stone
- [ ] cinDeRS

Lot no. ____

ton(neS) ____ to ____

ton(neS) SHippeD:

toDay ____

to Date ____

BaLance ____

SUBLot No.							SpeC. LIMItS		StatIStICaL aNaLYSIS		
toN(Ne) SaMpLeD											
SIeVe	MaSS (wt)	%	MaSS (wt)	%	MaSS (wt)	%	L	U	$\bar{X}$	S	pwL
100 mm (4")											
90 mm (3 1/2")											
75 mm (3")											
63 mm (2 1/2")											
50 mm (2")											
37.5 mm (1 1/2")											
31.5 mm (1 1/4")											
25.0 mm (1")											
19.0 mm (3/4")											
12.5 mm (1/2")	11.55	100	11.99	100	12.53	100	100	100	100	0.0	
9.5 mm (3/8")	10.28	89	10.42	87	11.30	90	85	100	89	1.5	
8.0 mm (5/16")											
4.75 mm (#4)	2.42	21	2.49	21	4.11	33	10	30	25	6.9	
2.36 mm (#8)	0.29	3	0.33	3	0.41	3	0	10	3	0.0	
1.18 mm (#16)	0.14	1	0.17	1	0.26	2	0	5	1	0.6	
600 µm (#30)											
425 µm (#40)											
300 µm (#50)											
150 µm (#100)											
75 µm (#200)											
MaSS (wt) or FM	11.56		12.02		12.55						

mat'l finer than 75µm (#200)	1067.4	1.39	1243.2	1.23	1143.4	1.79	0	1.0	1.47	0.3	
crushed fragments mass (wt) %											
unit weight kg/m³ (lbs/cf)											
coefficient of uniformity											
wet mass (wt)											
dry mass (wt)											

mateRiaL type: ____

teSteD By: ____
SouRce tecH.

WitneSSeD By: ____
Dept. inSpect.

ReVieWeD By: ____
county mGR.

____
D.m. unit

____
DiSt. enGR.

pWL ____

pay ____ %

$$\frac{\text{Wet maSS (Wt)} - \text{DRy maSS (Wt)}}{\text{DRy maSS (Wt)}} \times 100 = \text{\% moiStuRe}$$

RemaRKS

aVeRaGe $= \bar{X} = \frac{\sum_{i=1}^{n} X_i}{n}$

StanDaRD DeViation $= S = \sqrt{\frac{\sum_{i=1}^{n} (X_i - \bar{X})^2}{n-1}}$

$q_u = \frac{(u - \bar{X})}{S}$ $q_L = \frac{(\bar{X} - L)}{S}$

pWL $= (p_u + p_L) - 100$

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mat'L Spec type #8 - 1%	Date SampLeD ______	item numBeR	item quantity

pRoDuceR/Location ______________________

SyS	SR/po	SpuR	pHa	Sec	DiSt	co	❑ GRaVeL ❑ SanD ❑ SLaG ❑ coKe ❑ Stone ❑ cinDeRS

Lot no. ______
ton(neS) ______ to ______

ton(neS) SHippeD:
toDay ______
to Date ______
BaLance ______

SUBLot No.							SpeC. LIMItS		StatIStICaL aNaLYSIS		
toN(Ne) SaMpLeD											
SIeVe	MaSS (wt)	%	MaSS (wt)	%	MaSS (wt)	%	L	U	$\overline{X}$	S	pwL
100 mm (4")											
90 mm (3 1/2")											
75 mm (3")											
63 mm (2 1/2")											
50 mm (2")											
37.5 mm (1 1/2")											
31.5 mm (1 1/4")											
25.0 mm (1")											
19.0 mm (3/4")											
12.5 mm (1/2")	11.55	100	11.99	100	12.53	100	100	100	100	0.0	100
9.5 mm (3/8")	10.28	89	10.42	87	11.30	90	85	100	89	1.5	100
8.0 mm (5/16")											
4.75 mm (#4)	2.42	21	2.49	21	4.11	33	10	30	25	6.9	72
2.36 mm (#8)	0.29	3	0.33	3	0.41	3	0	10	3	0.0	100
1.18 mm (#16)	0.14	1	0.17	1	0.26	2	0	5	1	0.6	100
600 µm (#30)											
425 µm (#40)											
300 µm (#50)											
150 µm (#100)											
75 µm (#200)											
MaSS (wt) or FM	11.56		12.02		12.55						

mateRiaL type: ______

teSteD By: ______
SouRce tecH.

WitneSSeD By: ______
Dept. inSpect.

ReVieWeD By:
______
county mGR.
______
D.m. unit
______
DiSt. enGR.

pWL ______
pay ______ %

Wet maSS (Wt)-DRy maSS (Wt)
DRy maSS (Wt)
X 100 = % moiStuRe

mat'l finer than 75µm (#200)	1067.4	1.39	1243.2	1.23	1143.4	1.79	0	1.0	1.47	0.3	0
crushed fragments mass (wt) %											
unit weight kg/m³ (lbs/cf)											
coefficient of uniformity											
wet mass (wt)											
dry mass (wt)											

RemaRKS

aVeRaGe = $\overline{X} = \dfrac{\sum_{i=1}^{n} X_i}{n}$

StanDaRD DeViation $= S = \sqrt{\dfrac{\sum_{i=1}^{n}(X_i - \overline{X})^2}{n-1}}$

$q_u = \dfrac{(u - \overline{X})}{S}$ $q_L = \dfrac{(\overline{X} - L)}{S}$

pWL $= (p_u + p_L) - 100$

TR-4126A (9-08)

aggregate report

pennsylvania
DEPARTMENT OF TRANSPORTATION

- [ ] Fine aGG.
- [x] coaRSe aGG.
- [ ] anti SKiD

- [ ] acceptance
- [ ] VeRiFication
- [ ] inFoRmation

- [ ] conStRuction
- [ ] maintenance

p.o./cont. no

item numBeR

item quantity

mat'L Spec type #8 - 1%

Date SampLeD ______________

pRoDuceR/Location ______________

Lot no.______________

ton(neS)_____ to ______

SyS	SR/po	SpuR	pHa	Sec	DiSt	co

- [ ] GRaVeL
- [ ] SanD
- [ ] SLaG
- [ ] coKe
- [ ] Stone
- [ ] cinDeRS

ton(neS) SHippeD:

toDay ______________

to Date ______________

BaLance ______________

SUBLot No.							SpeC. LIMItS		StatIStICaL aNaLYSIS		
toN(Ne) SaMpLeD											
SIeVe	MaSS (wt)	%	MaSS (wt)	%	MaSS (wt)	%	L	U	$\bar{X}$	S	pwL
100 mm (4")											
90 mm (3 1/2")											
75 mm (3")											
63 mm (2 1/2")											
50 mm (2")											
37.5 mm (1 1/2")											
31.5 mm (1 1/4")											
25.0 mm (1")											
19.0 mm (3/4")											
12.5 mm (1/2")	11.55	100	11.99	100	12.53	100	100	100	100	0.0	100
9.5 mm (3/8")	10.28	89	10.42	87	11.30	90	85	100	89	1.5	100
8.0 mm (5/16")											
4.75 mm (#4)	2.42	21	2.49	21	4.11	33	10	30	25	6.9	72
2.36 mm (#8)	0.29	3	0.33	3	0.41	3	0	10	3	0.0	100
1.18 mm (#16)	0.14	1	0.17	1	0.26	2	0	5	1	0.6	100
600 µm (#30)											
425 µm (#40)											
300 µm (#50)											
150 µm (#100)											
75 µm (#200)											
MaSS (wt) or FM	11.56		12.02		12.55						

mat'l finer than 75µm (#200)	1067.4	1.39	1243.2	1.23	1143.4	1.79	0	1.0	1.47	0.3	0
crushed fragments mass (wt) %											
unit weight kg/m³ (lbs/cf)											
coefficient of uniformity											
wet mass (wt)											
dry mass (wt)											

mateRiaL type:

____

teSteD By:

____

SouRce tecH.

WitneSSeD By:

____

Dept. inSpect.

ReVieWeD By:

____

county mGR.

____

D.m. unit

____

DiSt. enGR.

pWL 79

pay 0 %

Wet maSS (Wt)-DRy maSS (Wt)

DRy maSS (Wt)

X 100 = % moiStuRe

RemaRKS

aVeRaGe $= \bar{X} = \frac{\sum_{i=1}^{n} X_i}{n}$

StanDaRD DeViation $= S = \sqrt{\frac{\sum_{i=1}^{n}(X_i - \bar{X})^2}{n-1}}$

$q_u = \frac{(u - \bar{X})}{S}$ $\quad q_L = \frac{(\bar{X} - L)}{S}$

$pWL = (p_u + p_L) - 100$

Appendix 52

TR-4126A (9-08)

aggregate report

pennsylvania
DEPARTMENT OF TRANSPORTATION

❑ Fine aGG. ☒ coaRSe aGG. ❑ anti SKiD	❑ acceptance ❑ VeRiFication ❑ inFoRmation	❑ conStRuction ❑ maintenance	p.o./cont. no
mat'L Spec type #8 - 1%	Date SampLeD ______	item numBeR	item quantity

pRoDuceR/Location ______

Lot no.______
ton(neS)______ to ______

SyS	SR/po	SpuR	pHa	Sec	DiSt	co	
							❑ GRaVeL ❑ SanD ❑ SLaG ❑ coKe ❑ Stone ❑ cinDeRS

ton(neS) SHippeD:
toDay ______
to Date ______
BaLance ______

SUBLot No.							SpeC. LIMItS		StatIStICaL aNaLYSIS		
toN(Ne) SaMpLeD											
SIeVe	MaSS (wt)	%	MaSS (wt)	%	MaSS (wt)	%	L	U	$\bar{X}$	S	pwL
100 mm (4")											
90 mm (3 1/2")											
75 mm (3")											
63 mm (2 1/2")											
50 mm (2")	35.80	100	38.53	100	34.94	100	100	100	100	0.0	100
37.5 mm (1 1/2")											
31.5 mm (1 1/4")											
25.0 mm (1")											
19.0 mm (3/4")	29.50	82	31.59	88	29.77	83	52	100	84	3.2	100
12.5 mm (1/2")											
9.5 mm (3/8")	21.16	59	20.15	58	16.99	47	36	70	54	6.2	100
8.0 mm (5/16")											
4.75 mm (#4)	11.62	32	11.91	33	7.00	20	24	50			
2.36 mm (#8)											
1.18 mm (#16)	4.7	13	4.6	13	4.9	14	10	30	13	0.7	100
600 µm (#30)											
425 µm (#40)											
300 µm (#50)											
150 µm (#100)											
75 µm (#200)											
MaSS (wt) or FM											

mateRiaL type: ______

teSteD By: ______
SouRce tecH.

WitneSSeD By: ______
Dept. inSpect.

ReVieWeD By:
______ county mGR.
______ D.m. unit
______ DiSt. enGR.

pWL 79
pay 0 %

$\frac{\text{Wet maSS (Wt)} - \text{DRy maSS (Wt)}}{\text{DRy maSS (Wt)}} \times 100 = \%$ moiStuRe

mat'l finer than 75µm (#200)	206.5	4.40	255.6	5.58	228.9	4.87	0	10	4.95	0.6	100
crushed fragments mass (wt) %											
unit weight kg/m³ (lbs/cf)											
coefficient of uniformity											
wet mass (wt)											
dry mass (wt)											

RemaRKS

aVeRaGe $= \bar{X} = \dfrac{\sum_{i=1}^{n} X_i}{n}$

StanDaRD DeViation $= S = \sqrt{\dfrac{\sum_{i=1}^{n}(X_i - \bar{X})^2}{n-1}}$

$q_u = \dfrac{(u - \bar{X})}{S}$ $\quad q_L = \dfrac{(\bar{X} - L)}{S}$

$pWL = (p_u + p_L) - 100$

NECEPT Aggregate Plant Technician Certification Program

VIII. Quality Control / Quality Assurance

VIII. Quality Control / Quality Assurance

Topics Discussed in this Section Include:

- Quality Control
- Record Keeping and Source Documentation
- Quality Assurance

Project Office Manual

- Here is how to get to the Project Office Manual Publication 2 commonly referred to as the POM.
  1. Go to the PENNDOT Home page at penndot.gov
  2. Click on the Forms and Publications on the right side of the page
  3. Next you want to filter results under the Document Type drop down select Publication
  4. Then under the Topic Type drop down select Project delivery
  5. The last step is to select Publication 2 this will open the POM

http://www.dot.state.pa.us/public/PubsForms/Publications/PUB%202/PUB%20 2

Quality Control

Quality Control is basically the process that the technician and their company takes to assure that all materials meet specification requirements.

Quality Control Technician is required to be NECEPT certified and performs the quality testing of aggregates.

The duties and responsibilities for the Quality Control Technician are established by the Quality Control Plan.

Quality Control

Minimum Quality Control Plan

REPLACES B.7.14	PENNSYLVANIA DEPARTMENT OF TRANSPORTATION	PART B	SECTION 7	PAGE 14-1
DATED 01/01/2008	PROJECT OFFICE MANUAL	DATE March 1, 2011		
SUBJECT **MINIMUM QUALITY CONTROL PLAN FOR AGGREGATE SUPPLIERS**				

The producer must submit a quality control plan to the District Materials Engineer/Manager annually. The purpose of this requirement is to insure that the producer will consistently produce a uniform and high quality product within Department specifications.

The following Quality Control Plan is a minimum plan designed to these standards.

A. Sampling and Testing Frequencies
The minimum testing frequency for all aggregate types will be at least one sample daily for the first 454 tonnes (500 tons) and one sample for each additional 907 tonnes (1,000 tons). Tests are to include, if applicable:

1. Gradations PTM No. 616
2. Wash Test PTM No. 100
3. Crush Count ASTM D 5821
4. Unit Weight AASHTO T 19 (To be tested twice a year or as required)

Tests other than gradations may be reduced to once weekly after uniformity has been established. For high volume aggregate production such as subbase material, sampling frequency may be increased to 907 tonnes (1,000 tons) daily and one for each additional 1,814 tonnes (2,000 tons). All changes to sampling/testing frequencies must be approved by the District Materials Engineer/Manager.

B. Department Stockpiles
Establish and positively identify aggregate stockpiles intended for Department use. At a minimum, the respective grading (AASHTO or PENNDOT) and specific use (if appropriate) will be provided.

C. Material Failures
Increase production testing frequencies to at least double the minimum required in Section A above until uniformity is established over five consecutive production days. Document all actions taken when failures are noted.

D. Certification
Certify each days shipments for each aggregate size to each project shipped, in accordance with Section 106.03(b)3, Publication 408.

E. Calibration of Mechanical Sieve Shaker
Calibrate mechanical sieve shaker in accordance with PTM No. 608 at the start of the season and when directed.

Must be submitted to the PennDOT District Materials Engineer (DME) for initial source approval and then annually for the life of the quarry.

C. Material Failures
Increase production testing frequencies to at least double the minimum required in Section A above until uniformity is established over five consecutive production days. Document all actions taken when failures are noted.

Quality Control

Aggregate Technicians test materials in the plant lab at intervals set forth by the Quality Control Plan.

Testing frequency is at least one sample daily for the first 500 tons and one sample for each additional 1000 ton.
Can be adjusted for high volume production.

1. Gradation PTM 616
2. Wash Loss PTM 100
3. Crush Count ASTM D 5821
4. Unit Weight AASHTO T 19 (performed twice a year or as required)

Quality Control

Source Evaluation Form TR-430A

TR-430A (10-73)

AGGREGATE SOURCE EVALUATION REPORT

Purpose: Preliminary ( ) Qualification ( )
Requalification (✓) Investigation ( )
Research ( ) Project ( )

Lab. No. PES38C14

District 8-0 Date 4/11/17
County Lebanon
Twp. or Boro. N. Annville

PERMANENT SOURCE
Producer Pennsy Supply, Inc. 1001 Paxton St. Harrisburg, PA 17105 (NAME AND ADDRESS)
Location Millard Quarry (AS LISTED OR TO BE LISTED IN BULLETIN)

TEMPORARY SOURCE ______ Contractor ______

L.R. ______ Section ______

Location of Aggregate Source: 1/2 miles from SR 0422 on L.R. or T.R. Syner Rd

Sec. ____ Lt. or Rt. ____ Township ____ on Mile Post ____ Pool ____ on ____ River

Processing Plant. Permanent (✓), Portable ( ), None ( ). If none, name of producer and location where material was processed to provide the samples submitted, if any ______

Superintendent or other contact: Name Tim Kindt Tel. (717) 821-7678

A. This source is proposed for new or continued listing in Bulletin 13 ( ), Bulletin 14, (✓), a temporary or project source ( ), or Bulletin 16, ( ) for one or more of the following materials.

1. Coarse Aggregate: Type A(✓), Type A, Bituminous Only ( ), C (✓); 2A Stone ( ), Gravel ( ), or Slag ( ), Recent ( ), or Reclaimed ( ), Blast Furnace ( ), Open Hearth ( ), Basic Oxygen ( ) Granulated ( )
2. Fine Aggregate: Type A ( ), B-Bituminous Only (✓), White ( ); Natural-Bank ( ), Pit ( ) River ( ) or Manufactured Sand from Conglomeratic Sandstone ( ) Limestone ( ) Other ______
3. Anti-Skid: ~~Type~~ AS 1 ( ), 2 (✓), 3 (✓), 4 (✓)
4. Mineral Filler ( )

B. Quality Control: Producer's records indicate that samples are tested at the rate of about 1/1000 samples per week or one sample per ______ ton(s).
These tests are made at this location (✓) or at ______
by employees of Same

At this location, the following equipment is available for quality control testing: ALL
None ( ), Mechanical shaker with timer for coarse aggregate ( ), For fine aggregate ( ), For Anti-Skid ( ), Standard sieves for coarse aggregate: 4" ( ), 3½" ( ), 2½" ( ), 2" ( ), 1½" ( ), 1" ( ), 3/4" ( ), ½" ( ), 3/8" ( ), #4 ( ), #8 ( ), #16 ( ), #100 ( ), #200. For fine aggregate: 3/8" ( ), #4 ( ), #8 ( ), #16 ( ), #30 ( ), #50 ( ), #100 ( ), #200 ( ). For Anti-Skid 1¼" ( ), ½" ( ), 3/8" ( ), 5/16" ( ), #8 ( ), #100 ( ). Unit Weight container one cubic foot, PTM 609 ( ), Balance, 2kg x 1/10 gram, ( ), Platform scale, 200 lb. x 1/10 lb. ( ), Hot plate, 2 burner ( ).

TR-430A (10-73)

Comments on the condition of the testing equipment and quality control records:

______

Excavation: The working face is being advanced in an N ( ), E (✓), S ( ), W ( ) ______ ly direction. The excavation is being carried out in such a way that contamination of the material by soil ( ), coal ( ), shale ( ), and or ______ ( ) is a major ( ), minor ( ), no (✓) problem. The method of excavating produces no ( ), few ( ), many ( ) oversize pieces that are reduced by drop ball ( ), blasting ( ), or are wasted (✓). The excavated material is transported to the processing plant by belt (✓), truck ( ), barge ( ). For details on the processing and stockpiling, as well as excavating methods, use extra sheets.

Stockpiling: The aggregate is transported to the stockpiles and placed by truck (✓), belt (✓), clam-bucket ( ), movable stacker ( ). The stockpiles are built by casting and spreading ( ), dumping off a ramp pile ( ), layering ( ), other ( ).

Evaluation: Because of the excavating ( ), processing ( ), stockpiling ( ) loading ( ), practices, the aggregate delivered to the job *site or plant is expected to contain* no (✓), little ( ), borderline ( ), excessive ( ), quantities of rock dust ( ), clay ( ), or other deleterious material such as ______
Particle shape is considered to be satisfactory (✓), unsatisfactory ( ), borderline ( ).

Samples for Requalification (PURPOSE) Submitted on 2017 (DATE).

If aggregate samples are within Specifications, source should be approved Yes (✓) No ( ).

PennDER Interim or Final Permit Number 1886

Additional Comments: All production is from the new area
Approved for rock.

Reported by [illegible] Title TCIS Date 4/11/17

Quality Control

Establish and Identify Department (PennDOT) stockpiles.

Record Keeping and Source Documentation

Three categories of record keeping are recorded in black ink and are kept in the Aggregate Source Document Book (State Book)

1. Records of Plant Production
2. Records of shipments to PennDOT
3. Source Records for Quality Requirements

Record Keeping and Source Documentation

Plant Production Records Include:

1. A copy of the Quality Control Plan approved by PennDOT.

2. A copy of the Aggregate Source Evaluation Report. (Form TR430A)

3. Records of production testing for State (Department) materials (Form 4211) with straight line analysis plots.

4. Records of equipment calibrations. Form (4211-E)

*Samples submitted to the PennDOT Materials Lab, Source Verification and Quality Assurance samples are to be included into the testing records.

Record Keeping and Source Documentation

Material Plant Book Table of Contents

CS-4211 (2-12)

MATERIAL PLANT BOOK TABLE OF CONTENTS

PLEASE TYPE OR PRINT IN BLUE OR BLACK INK ALL INFORMATION

pennsylvania
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www.dot.state.pa.us

FORM NO.	DESCRIPTION	AGGR. PLANT	BITC. PLANT	PCC PLANT
CS-4211	TABLE OF CONTENTS	X	X	X
CS-4211A	MATERIAL TEST RESULTS	X	X	X
CS-4211B	PROJECT SUMMARY	X	X	X
CS-4211C	SCALE CHECK	X	X	X
CS-4211D	PLANT SUMMARY	X	X	X
CS-4211E	MTD SAMPLE SUBMISSION RECORD	X	X	X
CS-4211F	COMPRESSION TESTS			X
CS-4211G	EXTRACTION TESTS		X	
CS-4211H	GRADATION OF HOT-BINS AGGREGATE BLEND		X	
CS-4211I	#57 AGGREGATE GRADATION	X	X	X
CS-4211J	#8 AGGREGATE GRADATION	X	X	X
CS-4211K	FINE AGGREGATE GRADATION	X	X	X
CS-4219A	DENSITY TEST RESULTS		X	
CS-4219C	ASPHALT PENETRATION RECORD		X	
CS-4221A	MOISTURE TESTS			X
CS-4221B	MATERIAL TEMPERATURES			X
CS-4221C	RECORD OF DAILY ORDERS AND RELEASES	X	X	X
CS-4221E	EQUIPMENT CALIBRATION RECORD	X	X	X
CS-4221F	401 LOT SAMPLES		X	
CS-4221G	ANTI SKID SUMMARY & MOISTURE RECORD	X		

Record Keeping and Source Documentation

Aggregate Test Result Form CS-4211

CS-4211A (2-12)

MATERIAL TEST RESULTS - AGGREGATE

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DATE															
SIEVE	BAND	MASS(WGT)	%PASS	MASS(WGT)	%PASS	MASS(WGT)	%PASS	MASS(WGT)	%PASS	MASS(WGT)	%PASS	MASS(WGT)	%PASS	MASS(WGT)	%PASS
ORIGINAL MASS															
% MASS LOST															
TESTED BY															
REMARKS															

Record Keeping and Source Documentation

Aggregate Test Result Form CS-4211

CS-4211J (2-12)

MATERIAL TEST RESULTS AGGREGATE NO. 8

PLEASE TYPE OR PRINT IN BLUE OR BLACK INK ALL INFORMATION

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DEPARTMENT OF TRANSPORTATION
www.dot.state.pa.us

DATE		04/17/2017		04/18/2017		04/18/2017		04/19/2017			
SIEVE	BAND	MASS (WGT)	% PASSING	MASS (WGT)	% PASSING	MASS (WGT)	% PASSING	MASS (WGT)	% PASSING	MASS (WGT)	% PASSING
12.5mm (1/2")	100	12.86	100.00	13.46	100.00	12.96	100.00	14.10	100.00		
9.5mm (3/8")	85-100	12.03	94.00	12.34	92.00	12.02	93.00	12.65	90.00		
4.75mm (#4)	10-30	3.38	26.00	3.14	23.32	3.60	28.00	2.96	21.00		
2.36mm (#8)	0-10	1.03	8.00	.87	6.00	1.2	9.00	.95	7.00		
1.18mm (#16)	0-5	.39	3.00	.27	2.00	.33	3.00	.12	1.00		
WASH			0.42		0.57		0.62		0.71		
CRUSH											
ORIGINAL MASS (WGT.)		12.89		13.59		12.94		14.00			
% MASS (WGT.) LOSS		0.23%		0.95%		0.15%		0.01%			
TESTED BY		Joe Technician		Joe Technician		Joe Technician		Joe Technician			
REMARKS				Shaker Loss exceeded maximum allowed by PTM. Shaker will be inspected and adjusted if necessary. Material will be resampled and retested.		Shaker springs were replaced and shaker times were re-calibrated. Sample meets all specifications.					

NOTE: MTD RECOMMENDED BREAKER SIEVES, 6.5mm (1/4")

Record Keeping and Source Documentation

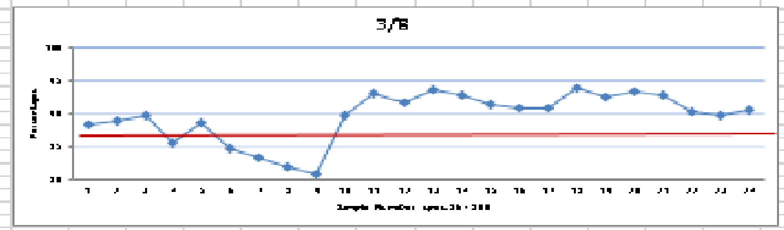
Aggregate Test Results Straight Line Charts

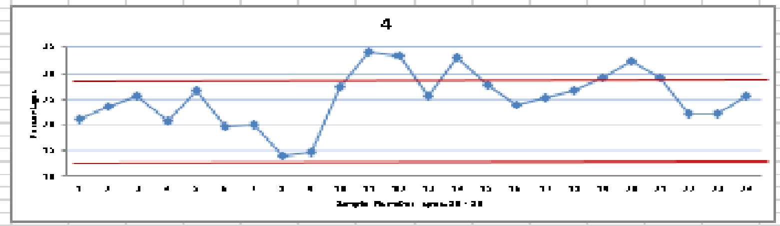
These charts are use to help control material and track the trends of material production.

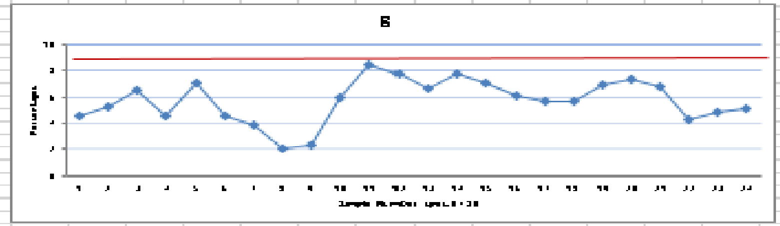
The charts must show specification limits and establish action points for critical test values.

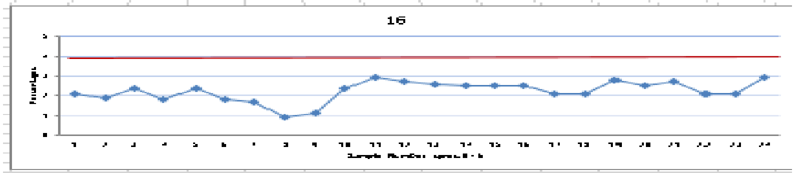
If one sample fails during your daily testing take action per the quality control action plan.

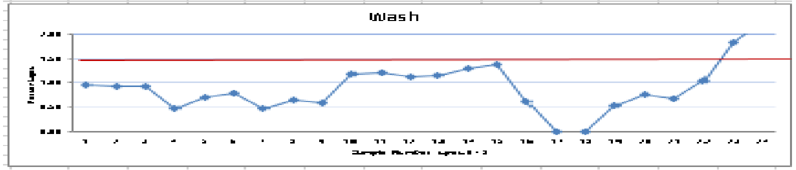
Materials that do not meet State spec can be sold commercially.











Record Keeping and Source Documentation

Record of Shipments to PennDOT

The aggregate tech must maintain a record of all materials being shipped and who released the material this includes:

1. Project Summaries
2. Certificates of Compliance
3. Anti-Skid Moisture Adjustments
4. Plant Summaries

Record Keeping and Source Documentation

Project Summary Form CS-4211B

CS-4211B (2-12)

PROJECT SUMMARY
PLEASE TYPE OR PRINT IN BLUE OR BLACK INK ALL INFORMATION

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SR ______________ SECTION ______________ CMS ______________

CONTRACTOR ______________ SUPPLIER CODE ______________

DATE	MATERIAL	DESIGN	TOTAL SHIPPED		DATE	MATERIAL	DESIGN	TOTAL SHIPPED	
			TODAY	TO DATE				TODAY	TO DATE

Shows the combined daily total tonnages shipped.

Separate page for each project shipped too.

Record Keeping and Source Documentation

Certificate of Compliance Form CS-4171

This is a Materials Certification form CS-4171 when signed it becomes a legal document, certifying that the materials have been tested and meet the specification requirements.

The CS-4171 is completed for each day's shipment of aggregates. A CS-4171 is required for each type of aggregate shipped.

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CS-4171 (8-16)

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DEPARTMENT OF TRANSPORTATION
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CERTIFICATE OF COMPLIANCE

1. ◆COUNTY:______ ◆LR/SR:______ ◆SEC/SEG:______ ◆ECMS#:______
(◆ - To be completed by the party that will ship the material to the project, otherwise leave blank.)

2. I / WE hereby certify that the material listed on line 5 was:
If a single company performs more than one operation (e.g., a company manufactures and coats guiderail), more than one box may be checked.
☐ Manufactured ☐ Fabricated ☐ Coated ☐ Precasted ☐ Produced
By Dauphin 0081 005 10541
(Name of Manufacturer, Fabricator, Coater, Precaster or Producer) (Supplier Code)

3. and the party listed above certifies that the material(s) on line 5 meets the requirements of
Publication 408, Section(s) ______
AASHTO, ASTM, Federal or other designation ______ x

4. The material listed below is being shipped to: Pennsy Supply Fiddlers PES22D14
(Company Name)

5. **LOT NO.** **QUANTITY** **APPROVED MATERIAL AS LISTED IN BULLETIN # 14 or 15 FOR BULLETIN # 41 or 42 PRODUCERS, LIST HMA / PCC JMF.**
703.2
AASHTO #57
John Doe Construction

6. ☐ **CHECK HERE IF YOUR PRODUCT CONTAINS IRON OR STEEL.** I certify the material identified above conforms to Sections 106.01 and 106.10(a) of Publication 408. 321.65 Tons AASHTO #57
CHECK ONE OF THE TWO BOXES:
☐ Product is 100% US Steel. ☐ Product contains minimal foreign steel in accordance with Act 3 and Buy America Attach receipts verifying the cost of the product's foreign steel and domestic steel.
CHECK THE BOX THAT APPLIES TO YOUR PRODUCT:
☐ 'Identifiable Steel' - Steel products that contain permanent markings that identify that the material was melted and manufactured in the United States. **Only Form CS-4171 is required.**
☐ Steel Products with In-Plant Inspection by a Department Representative - Steel products and products containing steel which received in-plant inspection by the Department or Department representative where it was verified that the steel was melted and manufactured in the United States. **Only Form CS-4171 is required.**
☐ 'Unidentified Steel' – Steel products that do not meet the definition of "Identifiable Steel" and do not receive in-plant inspection as defined above. **Attach supporting documentation including invoices, bills of lading and mill test reports that positively identify that the steel was melted and manufactured in the United States.**

7. **VENDOR CLASSIFICATION (CHECK ONE BLOCK ONLY) -**
☐ **#1 Manufacturer, Fabricator, Coater, Precaster Listed in Bulletin # 15, or Producer Listed in Bulletin # 14, 41 or 42**
I certify that the above statements are true and to the best of my knowledge, fairly and accurately describe the product(s) listed.
☐ #2 **Distributor, Supplier or *Private Label Company Not Listed in Bulletin # 15. Also, complete line 9**
I certify that the material being supplied is one and the same as provided to us by the manufacturer listed on this document and quantities listed above are accurate.

8. NAME (print) : Bill Technician TITLE: Technician
x
COMPANY NAME : Pennsy Supply
SIGNATURE : *Bill Technician* DATE: 01/05/2018
By Responsible Company Offical

9. List company that sold you the material(s) documented above: ______
(Complete if you checked Block # 2 on line # 7, otherwise leave blank.) (Company Name)

Record Keeping and Source Documentation

Plant Summary Sheet Form CS-4211D

The Plant Summary Sheet needs to be completed each day. This is needed to keep a running total of aggregates shipped.

CS-4211D (2-12)

PLANT SUMMARY - TOTAL COMBINED DAILY SHIPMENTS

PLEASE TYPE OR PRINT IN BLUE OR BLACK INK ALL INFORMATION

pennsylvania
DEPARTMENT OF TRANSPORTATION
www.dot.state.pa.us

SUPPLIER ______________________ SUPPLIER CODE ______________________

DATE	TODAY	TO DATE	DATE	TODAY	TO DATE	DATE	TODAY	TO DATE

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Record Keeping and Source Documentation

Required Delivery Ticket Information

A delivery ticket must accompany each load of material to be accepted on a project. The delivery ticket must contain the following information:

1. State Route and Section or P.O.
2. Contract Number
3. County and District
4. Aggregate Type
5. Date
6. Truck Number
7. Mass (Weight), Gross, Tare, Net
8. Lot Number
9. Signature of Licensed Weigh Master

Quality Assurance

Quality Control is basically the process that you and the company take to assure that materials meet specification requirements.

Quality Assurance is defined as what others do to make sure that the quality control plan has been followed.

Quality Assurance is performed by two groups District personnel and Central Office CQAS.

Quality Assurance

The District Materials Engineer / Manager (DME/DMM) or a member of their staff will visit each source shipping for the Department use at least once a year or once a month when the source is shipping a minimum 10,000 tons to the Department.

The District personnel will perform District Quality Assurance (DQA) checks, and will perform Source Verification Testing.

The PennDOT Construction-Quality Assurance Section (CQAS) will also visit the source to perform Independent Assurance (IA) / Quality Assurance Testing (QA).

Quality Assurance

Your plant will receive inspections from PennDOT personnel from the District and from the CQAS.

The District personnel will perform District Quality Assurance (DQA) checks, and will perform Source Verification Testing.

CQAS will visit the plant to perform QA or IA Testing.

Quality Assurance

Verification and Quality Assurance Samples		
Type of Sample	Frequency / Quantity	Tested at and by Whom
1. Quality Control Plan	Minimum 1/day for first 500 tons; extra 1/day for each additional 1,000 tons	At source by Aggregate Technician
2. Source Verification	Minimum 1/year; 1/month for 5,000 tons to 50,000 tons; additional visit for each additional 25,000 tons	At source by Department Inspector (Collected by Aggregate Technician)
3. Project Verification: (Collected at point of placement)	1/sample for >1000 tons <2,000 tons 2/samples for >2,000tons <10,000 tons 3/samples for >10,000 tons <25,000 tons 1/sample for each additional 25,000 tons Number of Sample (n=3)	At source by Aggregate Technician, or Field Lab if there are problems with PWL
4. District Verification	Minimum 1/year; 1/month for 5,000 tons to 50,000 tons; additional visit for each additional 25,000 tons	At source by Certified Department Inspector (Collected by Aggregate Technician)
5. Quality Assurance: (District or CQAS)		Laboratory Testing Section (LTS) Harrisburg

Quality Assurance

Sampling of Materials

There are 5 types of samples:

1. Qualification Samples – Are obtained for new aggregate sources and for new aggregate types to be added to Bulletin 14. These samples are tested at the LTS. A full battery of Quality tests are performed, an SRL rating is given, and ASR testing for coarse and or fine aggregates is performed.

2. Requalification Samples – Are obtained biennially from sources that are already listed in Bulletin 14. These samples are tested at the LTS. Used to track changes and to watch the quality of the aggregate.

3. Source Verification Samples – These are samples that are taken at the source, tested by a Certified Department Inspector, for each state stockpile that you have identified.

4. Project Verification Samples – These samples are taken at the point of placement prior to compaction, with the supervision of a field (project) PennDOT inspector.

5. Quality Assurance Samples – are samples obtained by the CQAS Division to assure that quality standards are being maintained. Samples are test at the PennDOT Lab.

Quality Assurance

Requalification Samples

Are taken on a Biennially (2 Year) Cycle or Annually depending on what district your working in.

If one of the Requalification samples fails a quality test (i.e.. Sodium Sulfate, L.A. Abrasion) the source may be suspended from Bulletin 14 for that particular product.

Quality Assurance

Source Verification Samples

These samples are lifted by the Aggregate Technician and tested at the plant by a Certified Department Inspector, or the samples could be sent to the LTS.

Three samples (n=3), are taken from mini stockpiles of approximately 10 tons with a flat-bladed shovel.

Samples are taken from each identified state stockpile.

Quality Assurance

Project Verification Samples

Publication 408 Section 703 Table F	
Project Verification Samples	
Aggregate Quantities	Number of Samples (n=3)
1000 tons or more, but less than 2,000 tons	1
2,000 tons or more, but less than 10,000 tons	2
10,000 tons or more, up to 25,000 tons	3
Each additional increment of 25,000 tons	1

Samples are taken from the project based on the tonnages shipped to the job.

Three samples are taken per lot (n=3)

Quality Assurance

Project Verification Samples

Aggregate Technician or Aggregate Technician and Certified Department Inspector travel to the project site and meet with the Project Inspector(s).

Project Inspector(s) will select sample locations based off of PTM #1.

The samples are taken in place prior to compaction.

Samples are then taken to the Quarry Lab and tested by the Certified Department Inspector.

Quality Assurance

Project Verification Sampling

If the material does not conform to the specifications the Certified Department Inspector will determine the PWT for that lot of samples.

If the PWT is less than 90%, the job is to be notified immediately and another sample is taken at the Project site from the next 150 tons of material that is shipped. Shipment of the material is then stopped until the results of the second sample (n=3) are determined.

If the results indicate a PWT of 90% or more resume shipment of materials to the job. If the PWT is less than 90%, then acceptance testing at the point of placement will occur.

Quality Assurance

Project Verification Sampling

If the PWT is less than 90, conduct acceptance testing at the point of placement according to the following procedure:

1. Providing a separate field lab at no additional cost to the Department. Do not resume the operations using the material until the field laboratory is in place.

2. Under the direction and supervision of the inspector, obtain an acceptance sample (n=3) at the point of placement for each day's placement according to PTM 1. The samples are immediately transported to the field lab and tested.

3. The Department will continue project acceptance testing until 10 consecutive days placements are accepted with no rejected material. The contractor is charged $600 per day for each day the material is placed.

4. For test values not meeting the specifications the Department will determine the PWT. If the results PWT is less than 90% the materials are removed and replaced at no additional cost to the Department.

Quality Assurance

QA Sampling

QA samples (n=3) may be taken by CQAS at the source of supply or at the point of placement on the project.

Samples are submitted to the PennDOT Lab for testing. If the PWL is less than 90%, the District will come and take verification samples at the plant or on the project site. If the results are less than 90% both project verification and source verification samples are taken. (n=3)

Quality Assurance

IA Sampling

Each construction season, CQAS performs a minimum of 10 Aggregate Independent Assurance reviews in each District at aggregate sources shipping material to Department projects. Included among these reviews are aggregate sources shipping material to federal-aid projects on the National Highway System meeting the following minimum project quantities:

No. 2A Aggregate Subbase:	1 Review > 50,000 yd^2
No. 57 Structure Backfill:	1 Review > 5,000 yd^3

Quality Assurance

IA Sampling

An IA sample (n=1) will be taken from an approved Department stockpile under the Certified Department Inspector. The Independent Assurance sample will be split into 2 equivalent samples for testing. In addition, a representative sample will be obtained for an IA Wash Test at the LTS.

One sample will be tested by a Certified Department Inspector and one sample will be tested by the Aggregate Technician, both using the same equipment. The sample tested by the Aggregate Technician will then be re-bagged and sent for testing to the LTS for testing.

Test results from the source will be compared to the IA precision tolerances by CQAS. Those results will then be compared with the test results obtained by LTS for compliance with the Independent Assurance precision tolerances.