FIELD GUIDE

FOR THE ACCEPTANCE OF HOT MIX ASPHALT AND BRIDGE DECK WATERPROOFING

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August 2016

To all users of the: **FIELD GUIDE FOR THE ACCEPTANCE OF HOT MIX ASPHALT AND BRIDGE DECK WATERPROOFING, AUGUST 2016**

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PREFACE

This Field Guide has been prepared by the Bituminous Section of the Materials Engineering and Research Office to provide procedural guidelines to administer End Result Specification (ERS) Contract requirements on Ministry of Transportation projects in Ontario with Special Provision 103F01. For Contracts without Special Provision 103F01, please refer to the 2009 "Field Guide for Acceptance of Hot Mix and Bridge Deck Waterproofing" in combination with the Contract Documents. The purpose of this Field Guide is to uniformly implement, across the Province, the acceptance procedures for Hot Mix Asphalt (HMA) and bridge deck waterproofing.

The Field Guide is not a specification and does not form part of the Contract between the Ministry and the Contractor. Neither the Ministry nor the Contractor is bound by the contents of this Field Guide unless agreed to in writing, in whole or in part, by both parties.

The Field Guide is primarily intended for use by Ministry of Transportation Regional Staff as well as Consultants administering Ministry Contracts involving HMA and bridge deck waterproofing. This Field Guide outlines the required sampling, testing, and recommended acceptance procedures, in accordance with the applicable Ontario Provincial Standard Specifications (OPSS) and current Ministry Special Provisions.

This Field Guide should be read in conjunction with the "Construction Administration and Inspection Task Manual" (CAITM) and the Contract Documents. For Minimum Oversight and Design Build Contracts refer to the "Contract Administration Guidelines for Minimum Oversight Contracts" and the "Design-Build Construction Administration Manual", respectively.

Any wording changes since the 2015 Field Guide are shown in bold.

MAJOR CHANGES SINCE THE 2015 FIELD GUIDE

This section highlights some of the major changes that have been made since the **2015** Field Guide was published.

Chapter 1 - Submissions

- **Section 1-1.1 on Warm Mix Asphalt (WMA) has been added.**
- **Conditional situations for allowing field adjustments to JMF during production removed.**

Chapter 4 – Acceptance of Hot Mix Asphalt based on Visual Observation

- **Figure added to section 4-4 showing examples of surface defects.**

Chapter 6 – Acceptance of Hot Mix Asphalt based on Smoothness

- **The use of GPS-DMI technology is allowed.**

Chapter 8 – Acceptance of Tack Coat

- **When an alternative tack coat product is used, three extra cores are requested to be sent to the MERO Bituminous laboratory for bond strength testing for information purposes.**

2015-2016 INITIATIVES

Always check the Contract Documents for any initiatives, trials, or modifications of the OPSS and Special Provisions that take precedence over this Field Guide.

Additional PGAC Acceptance Criteria

- Special Provision 111F09 has been updated to include the following changes to the acceptance criteria for Performance Graded Asphalt Cement (PGAC):
  - Ash content acceptance limit has been lowered to 0.8 for all grades except 52-40 and 58-40. In addition, there is now a criterion for major borderline (payment reduction) for all grades except 52-40 and 58-40.
  - The acceptance limit for $J_{nr\text{-}3.2}$ has been raised from 4.0 to 4.5 to match the AASHTO M 332 requirement.
  - The rejectable limit for $R_{3.2}$ has changed.
  - There **is** a criterion for major borderline Crack Tip Opening Displacement (CTOD) results.
  - Tender Opening Date Reduction Factors (TODRF)**, in Table 3 of 111F09, are** only applicable to payment reductions as a result of major borderline CTOD results.
- **Special Provision 111F09M is inserted in numerous Contracts** with acceptance criteria based on LS-308 (Extended BBR) testing (instead of testing for information purposes only).
- There may be a few trial Contracts where PGAC is graded using the MSCR test in lieu of high temperature grade bumping for heavy/slow traffic. **Requirements are included in a modified Special Provision 111F09M.**

Stone Mastic Asphalt (SMA)

- Pause on SMA has been lifted, which means there will be an increase in the number of Contracts specifying the use of SMA.
- When SMA is specified, it will require gritting **the SMA surface with coated gritting material** and there are additional sampling requirements associated with the use of **coated** grit.
- In addition, the Contractor must submit the gradation and physical properties of the gritting material five Days prior to the start of gritting and the Contract Administrator must confirm the gritting material is acceptable.
- The spread rate of 0.75 ± 0.1 kg/m^2 **of coated gritting material** must be verified by a demonstration area prior to the start of gritting **the SMA surface**.
- For additional requirements, refer to the NSSP included in the Contract Documents.

Fibre Reinforced Hot Mix Asphalt

- **In 2016, there may be a number of Contracts where Fibre Reinforced HMA is specified as trial sections along with a control section.**
- **A detailed plan must be submitted at the pre-start meeting.**
- **As built sketch and GPS coordinates of each test section are to be obtained.**
- **Samples shall not be taken from transition areas.**
- **Additional samples are to be sent to MERO Bituminous laboratory.**
- **For additional requirements, refer to the modified version of 103F01 included in the Contract Documents.**

Performance Requirements for Surface Course Joints

- **In 2016, there may be a few select Contracts where a 5 year warranty is specified for the surface course joints.**
- **Within 150 mm of surface course joints there are performance requirements for coarse aggregate loss (including ravelling and potholes), crack width, and sealed cracks.**
- **Potholes with an area of 0.04 m^2 or greater within 150 mm of a surface course joint shall be repaired means approximately 200 mm x 200 mm or 4" x 4" or a circle with a diameter of 200 mm or any combination equaling 0.04 m^2 or 0.1 sq ft.**
- **For additional requirements, refer to the modified version of 103F01 and the Special Provision for Administration of Surface Course Joint Performance Specifications in the Contract Documents.**

Smoothness Measurement

- **The use of GPS-DMI (Global Positioning System-Distance Measuring Device) is allowed.**
- **GPS-DMI is a system that uses a GPS receiver for measuring the longitudinal distance along a profile when using an inertial profiler. All the QA and referee inertial profilers are now equipped with GPS-DMI. The use of either GPS-DMI or reflector cones is at the discretion of the profiler operator. Special Provision 103F01 and LS-296 have been revised to allow the use of GPS-DMI.**

Sample Delivery

- **MTO is in the process of changing how material sample deliveries are done on contracts moving from contractor sample delivery to owner/owner representative sample delivery. At time of publication, MTO had not finalized the roll out plan. For individual contracts, refer to SP 199F57 for details on who is responsible for the sample delivery.**

Web-Based Contract Management Services (WBCMS-MTO)

- **In 2016, the MTO is delivering a suite of Web-Based Contract Management Services (WBCMS-MTO) that will revolutionize the way that contracts for Construction, Construction Administration and Material Quality Assurance Testing Services are managed throughout the entire contract delivery lifecycle from award to close. External service providers are required to use the new solution to record contract activities and laboratory and field data electronically. This solution will replace a wide variety of paper-based methods of recording contract activities in diaries, spreadsheets and stand-alone databases. WBCMS-MTO for MTO's Engineering and Maintenance contracts will be delivered in subsequent phases.**
- **The Ministry, its external service providers and its contractors will access the new system and its services via an internet browser from their desktop, laptop, tablets and or mobile devices.**
- **WBCMS-MTO is browser based and sustained via a subscription model. It will be the responsibility of the Service Provider to obtain the necessary internet access to the WBCMS-MTO and ensure that there is connectivity to record activities.**
- **Any reference in the Contract Documents, CAITM, or this Field Guide to forms shall be deemed to mean the electronic equivalent of that form and rendered as a record within WBCMS-MTO.**
- **WBCMS-MTO will be available for use in 2016 for managing Material Quality Assurance Testing Services. Testing services for individual construction contracts will be administered by WBCMS-MTO when the date of the Permission to Start Work is subsequent to the implementation of WBCMS-MTO.**
- **For more information on WBCMS-MTO, please visit http://www.aurigo.com/wbcms-mto/.**

Chapter One

SUBMISSIONS

1-1 General

The Contract Administrator should ensure the Contractor submits all the required documentation and submission requirements as stated in the Contract Documents, which may include some of the following specifications that will be referenced throughout this Field Guide:

- Special Provision 103F01 that deletes and replaces OPSS.PROV 313, which for the purposes of this Field Guide will be referred to as “F01”;
- Special Provision 111F11 that deletes and replaces OPSS.PROV 1151, which for the purposes of this Field Guide will be referred to as “F11”;
- OPSS.PROV 1101, which for the purposes of this Field Guide will be referred to as “1101”;
- Special Provision 111F09 that amends OPSS.PROV 1101, which for the purposes of this Field Guide will be referred to as “F09”;
- Special Provision 110S12 that deletes and replaces OPSS 1003, which for the purposes of this Field Guide will be referred to as “S12”;
- OPSS 1001, which for the purposes of this Field Guide will be referred to as “1001”; and
- OPSS.PROV 308, which for the purposes of this Field Guide will be referred to as “308”.

1-1.1 Warm Mix Asphalt

Wherever Hot Mix Asphalt (HMA) is referred to throughout the Field Guide, it also includes mixes produced using Warm Mix Asphalt (WMA) technologies. WMA mix design shall follow LS-318. Use of WMA on Ministry Contracts is currently permissive, meaning a Contractor can use WMA instead of HMA. Similar to HMA, WMA may be paid either by tonnage or by square metre, depending on the unit of payment for the HMA item in the Contract.

There may be a number of Contracts where WMA is specified. In these Contracts, WMA is required by specifying warm mix item(s). Contractors do not have the option to switch to HMA in these Contracts. All the WMA requirements are now included in Special Provisions 103F01 and 111F11.

If WMA is used, the Contractor must submit the GPS coordinates of the WMA paving limits within seven Days after completion of WMA paving.

1-2 Prior to the Start of Paving

Refer to the “Construction Administration and Inspection Task Manual” (CAITM) for the Contract Administrator’s responsibilities. In addition to the requirements in the CAITM, at the pre-pave meeting, the Contract Administrator should make the Contractor aware that plate sampling is not

recommended, but if it is used and the sampling locations are not restored properly, the Contractor must repair the lane as required for surface appearance defects.

1-2.1 Contractor Mix Design (F11)

For each mix, the Contractor must submit a mix design to the Contract Administrator. The Contract Administrator should e-mail the mix design that conforms to the Contract Documents in a single PDF document to the Regional Quality Assurance Section, the Contract Services Administrator, and bituminous@ontario.ca ensuring the following file naming convention is used.

A typical file name should consist of up to 30 characters (i.e. *2015-3002_SMA095_PG58-28_01 or 2015-2138_SUP125FC2_PG64-34_02*). The first nine (usually) characters (i.e. *2015-3002* or *2015-2138*) will represent the Contract number. An underscore ("_") should then separate the next three to nine characters (*i.e. SMA095 or SUP125FC2*) which represent the mix type, designated in accordance with the following recommended codes:

Mix Type	Recommended Code
Superpave 37.5	SUP375
Superpave 25.0	SUP250
Superpave 19.0	SUP190
Superpave12.5FC 2	SUP125FC2
Superpave12.5FC 1	SUP125FC1
Superpave12.5	SUP125
Superpave 9.5	SUP095
Superpave 4.75	SUP0475
Stone Mastic Asphalt 19.0	SMA190
Stone Mastic Asphalt 12.5	SMA125
Stone Mastic Asphalt 9.5	SMA095
Rich Bottom Mix	RBM

A second underscore ("_") will follow the mix type, which is then followed by the asphalt cement performance grade (i.e. PG58-28). A third underscore will follow the grade ("_") which is then followed by the last two characters before the extension which identifies the version number (i.e. 01 for first mix design for each mix type or 02 for a new mix design or revision to the mix design for SUP125FC2, etc.).

Each mix design is valid for a maximum of 14 months from the date the mix design was prepared. The use of a mix design can be extended for the remainder of the calendar year past the initial 14 months if a One Point Mix Check (OPMC) meeting the requirements of F11 and LS-316 is submitted to the Contract Administrator. The OPMC can be completed by any certified mix design laboratory; it does not have to be completed by a third party. When considering conflict of interest, a laboratory that completes an OPMC would be considered the same as a laboratory that completes a mix design. If the OPMC is submitted close to the end of the calendar year, the Contract Administrator should consider extending the mix design for 12 months (rather than just the rest of the calendar year). The mix design can continue to be extended after each extension with the submission of another OPMC. However, up to three adjustments to the Job Mix Formula (JMF) are permitted over the life of the mix design (see section 1-3). If the Contractor wishes to adjust the JMF of an extended mix design and it has already had the maximum number of adjustments, a new mix design submission is required.

New samples for aggregate density (see section 2-2.1) must be submitted within two Days of submission of an OPMC.

In addition, mix design submissions can be used on multiple Contracts, if the following conditions are met:

a) The materials used in producing the mix design (Aggregates, Performance Graded Asphalt Cement, any Additives, and Modifiers) are representative of the materials that are going to be used in producing the HMA for the Contract.
b) The materials and the resulting HMA meet the Contract requirements.
c) The mix design must be carried out in accordance with Contract requirements. This includes the compaction effort associated with the traffic category.
d) The mix design must be identified by the design lab/HMA producer with a unique identifier number. When an OPMC is submitted, the unique identifier number must also be quoted on the mix design OPMC form (PH-CC-822_OPMC).

As a result, the "One Point Check for Superpave Mix Designs" form PH-CC-822_OPMC has a placeholder to insert the unique identifier number. The MTO Contract number should not be quoted on a mix design form that has been prepared for use on multiple Contracts. The Contract number can be supplied in a cover letter.

The Owner may not verify all mix designs. **The Contract Administrator should only request material samples, used for the mix design, when directed to do so by the Regional Quality Assurance Section.** After receiving all required documents and samples from the Contractor, the Contract Administrator will review the mix design and the JMF and provide the Contractor with written confirmation advising of any non-conformances within four Business Days.

A form letter from the Contract Administrator, entitled "Hot Mix Asphalt Mix Designation" (PH-CC-872) is available for confirming conformance.

The Contractor must not place any mix prior to receiving this written confirmation from the Contract Administrator as stated in the Mix Design clause of F11.

Note 1-1: JMF changes that were previously approved (on current or other Contracts) do not become part of the mix design.

1-2.1.1 Percent Reclaimed Asphalt Pavement / Roof Shingle Tabs (F11)

Reclaimed Asphalt Pavement (RAP) content is expressed as a percentage of the *TOTAL MIX BY MASS* (i.e. aggregate, asphalt cement, RAP etc.). It is important to understand that this is different from how RAP content is reported in a mix design. In that case, RAP is reported as a percentage of the *total aggregate by mass.*

It is important to note that this impacts calculations made to determine the amount of new Asphalt Cement (AC), which is added to a mix that contains RAP when calculating the payment adjustments for the new AC (see section 5-6.3).

Note 1-2: These comments apply to Roof Shingle Tabs (RST) as well.

Any products or materials used to keep the RST from clumping must be approved by the Owner.

1-2.2 Prior to Use of HMA Aggregates (S12, 1001, & F11)

The Contractor must submit the source of each aggregate prior to paving. If aggregates were treated with an **Aggregate Anti-Stripping Treatment such as Hydrated Lime or an approved alternative,** and stored from a previous construction season, the Contractor must submit a

written proposal that verifies the effectiveness of the stored aggregates and cannot use the aggregates until the Contract Administrator agrees. The Contract Administrator should review the proposal with the appropriate Quality Assurance Section, who in turn will contact Head Office if necessary.

1-2.3 Prior to Use of Coated Gritting Materials for SMA (NSSP)

The Contractor must submit the gradation in accordance with LS-602 and the physical properties of the proposed gritting materials at least five Business Days prior to the start of gritting. The Contract Administrator must issue confirmation that the proposed gritting materials are acceptable prior to the placement of the **coated** gritting material **on SMA surfaces**.

1-2.4 Prior to Use of PGAC (F01 & 1101)

The Contractor must submit the purchase price of the Performance Graded Asphalt Cement (PGAC), signed by the Contractor's senior financial officer prior to the start of paving.

At least 14 Days prior to the first use of each grade of PGAC, the Contractor must submit:

a) PGAC supplier, facility type, and location supplied from;
b) PGAC construction, storage, and handling requirements;
c) PGAC mixing and compaction temperatures;
d) recompaction temperature, mix discharge temperature, and extraction procedure;
e) when paving on bridge decks, the minimum temperature of the HMA after spreading, as recommended by the supplier;
f) when a PGAC contains PPA and a liquid ASA is added to the PGAC by the supplier:
   i) how much ASA was added; and
   ii) documentation from the PGAC supplier that the PGAC with the additive will meet AASHTO M 320 for the grade specified.

1-2.4.1 Prior to Use of PGAC with Anti-Stripping Additives (F11)

a) If the ASA is added by the PGAC supplier:
   The Contractor must submit the ASA and PGAC Document and documentation confirming the type and concentration of the liquid ASA for each tanker of PGAC.

   or

b) If the ASA is added at the HMA plant:
   The Contractor must submit the ASA and PGAC Document and documentation confirming the type and concentration of the liquid ASA along with a statement of calibration for the metering device and a continuous record of the process for each batch of PGAC with liquid ASA.

1-2.5 Prior to Use of Tack Coat (308)

The Contractor must submit the following at least five Days prior to the first use of tack coat on the Contract:
a) documentation identifying the proposed supplier and applicator;
b) material safety data sheets; and
c) any other information for the safe handling and storage of the product.

1-2.5.1 Prior to Use of an Alternative Tack Coat Product (308)

The use of **alternative** products other than diluted SS-1 will be permissible. Such requests are likely to be made for **alternative products like non-tracking tack coat (for improving break time, and eliminating tracking) and other products for** late season paving or for paving situations when a "fast break" of the emulsion is desirable (e.g. night paving).

The Contractor must submit the following in writing at least seven Days prior to the intended use of the proposed alternate products:

a) the reason for the use of the alternative material;
b) material safety data sheets and any other information for the safe handling, transportation, and storage of the product;
c) testing protocols to be used in confirming the properties of the material;
d) typical test results;
e) required application rates; and
f) cost implications for the use of the alternative product.

The Contract Administrator will be required to respond in writing within five Days by either agreeing to the proposal or not accepting it with reason(s). When such a request is received, the Contract Administrator must review it with the applicable Quality Assurance Section, who in turn will contact Head Office if necessary.

1-2.6 Prior to Paving on Bridge Decks (F01)

The Contractor must submit the mass of the rollers to be used on the bridge deck (except Class V rollers) and the Contract Administrator shall verify they meet the requirements of the Rollers on Bridge Decks clause of F01.

1-3 Field Adjustments to the Job Mix Formula (F01)

The criteria for making field adjustments to the JMF are detailed in the Field Adjustments to the Job Mix Formula clause of F01.

Definition

A field adjustment to the JMF is defined as a change in the target gradation, AC content or both of a mix, within limits as specified in the Contract Documents without a redesign of the HMA, resulting in an adjusted JMF.

Submission

The adjusted JMF must be supplied in writing on the PH-CC-866 form to the Contract Administrator. JMF adjustments will not be accepted once placement of the specific mix type has been completed. The Contract Administrator must provide the Contractor with a written confirmation of the adjusted JMF confirming conformance or advising of non-conformances within one Business Day of receiving the JMF adjustment submission.

The adjusted JMF may be applied to the lot being placed at the time the confirmation of **receipt of** the adjusted JMF is issued, and the previous lot, if requested by the Contractor, as part of the written submission for a JMF adjustment. If this request is not made, then the adjusted JMF will **only** apply to any mix placed **after the receipt** of the adjusted JMF.

Number of Permitted Changes

The number of field adjustments to the JMF is limited to three for each mix design submitted for a given item. One prior to production and two during production.

Maximum Permitted Change

Field adjustments must be limited in scope such that the net impact of all of the adjustments does not exceed any of the requirements given in Table 1 entitled “Maximum Field Adjustments for JMF” of F01, in comparison to the original JMF submitted under the current mix design.

It should be noted that, if a JMF adjustment results in a decrease in the design AC content, the lower limit (LL) must now be set at the adjusted JMF minus 0.3% for all lots to which the JMF applies (see Note 1 beneath Table 5 in F01). It is also important to note that this must be changed on the ERS - Hot Mix Asphalt Pay Factor Calculation spreadsheet (see section 3-3.1) for every lot that a JMF adjustment results in a decrease in the design AC content. When the JMF is adjusted, it should be documented on the pertinent weigh ticket and/or inspector's diary.

1-4 Calcium Chloride

When a Contractor suspects that the placement of calcium chloride prior to HMA paving will prevent the placement of durable HMA, the Contractor can submit a written request for the Owner to review the problem on a site-specific basis.

1-5 Before the End of each Calendar Year

Before the end of each calendar year, the Contract Administrator must completely fill in all tabs in the Year End Summary “Hot Mix Summary” form (PH-CC-847) and submit the completed form to the Regional Quality Assurance Section, copied to soils-aggregates@ontario.ca, and bituminous@ontario.ca. If any difficulties are encountered with the spreadsheet, please contact: John Blair at (416) 235-3743 or the email addresses given above.

Chapter Two

SAMPLING HOT MIX ASPHALT MATERIALS

2-1 General

For the purposes of this chapter, Ontario Provincial Standard Specifications (OPSS) and Special Provisions will be referred to as detailed in section 1-1.

Guidelines for sampling Hot Mix Asphalt (HMA) materials can be found in the following sections:

- Sampling for density testing of HMA aggregates and calculating Voids in Mineral Aggregate (VMA) is in section 2-2;
- Sampling of HMA aggregates for physical and consensus properties is in section 2-3;
- Sampling of HMA for mix and volumetric properties is in section 2-4;
- Core sampling of HMA for compaction is in section 2-5;
- Core sampling of HMA for lift thickness is in section 2-6;
- Sampling of Stone Mastic Asphalt (SMA) gritting materials is in section 2-7;
- Sampling of Performance Graded Asphalt Cement (PGAC) is in section 2-8;
- Guidance on setting up lots and sublots is in section 2-9;
- Measurement of smoothness is in chapter 6;
- Sampling of tack coat is in chapter 8; and
- Sampling of bridge deck waterproofing is in chapter 9.

Once samples are obtained by the Contractor in the presence of the Contract Administrator or a designated representative, the Contract Administrator shall take and maintain continuous possession of the samples until they are **sealed and ready for delivery**.

The Contract Administrator or a designated representative must provide and fill out the appropriate sample data sheet and the data sheet shall be signed by the Contract Administrator and the Contractor. The packaged (i.e. bag, box, etc.) samples should be placed in heavy gauge plastic bags with the completed sample data sheet.

Each bag shall have an area in which the date and the Security Seal code and all other relevant information can be written using a regular permanent magic marker. The bags and seals may be obtained from the appropriate Regional Quality Assurance Section. The Contract Administrator or designated representative must then verify the information on the bag is correct and seal the bag with a Security Seal (tie wrap) which has a customized MTO code. When the seal is applied, he/she must then write the same code on the bag along with the date the bag was sealed. The samples shall then be delivered to the appropriate laboratory.

2-2 Sampling for Density Testing of HMA Aggregates and Calculating VMA (F01)

2-2.1 Sampling for Density Testing of HMA Aggregates (F01)

No later than ten Days prior to the start of production of the first lot of HMA, the Contractor must take the first set of two samples for each aggregate identified in the mix design for each mix type, including Reclaimed Asphalt Pavement (RAP) and New Roof Shingle Tabs (RST), if used, in accordance with the Hot Mix Asphalt Aggregates for Density Testing clause of F01.

During HMA production, the Contractor is required to take a set of two samples for RAP, RST, and each aggregate identified in the mix design, immediately after the completion of 15,000 tonnes (± 1,000 tonnes) of HMA, and thereafter at intervals of 20,000 tonnes (for payment by square metre Contracts use the formula in section 2-4.2.1 to convert tonnages to square metres). **To reflect changes in the aggregate properties, a new set of samples can be taken when requested by the Contractor**. The sampling may be performed during the production of each aggregate, RAP, and RST (if RAP and/or RST is included in the mix) or during the stockpiling of the materials at the HMA plant.

A set of two samples for each aggregate shall be taken; each set of two samples should be delivered to the QA laboratory without marked designation or they could be marked “1” and “2”. The Contract Administrator or the QA laboratory will choose one of the two for QA testing and retain the other for referee testing, if required. The Aggregate Sample Data Sheet (PH-D-10) must accompany the samples.

2-2.2 Calculating VMA (F01)

The calculation of VMA is based on testing carried out on samples submitted with the mix design, or the revised mix design if applicable, averaged with the determination of densities on the specified QA samples obtained during HMA production. Results of aggregate density tests, for samples taken during HMA production, are applicable only to the lots subsequent to the lot during which they were taken. The conditions for referee testing are given in section 5-3.

The calculation of VMA is based on the densities of the blended coarse and the blended fine aggregates (instead of mathematically combining the densities of the individual aggregates for the coarse and fine). The individual VMA’s will be calculated to two decimal places but the lot mean will only be calculated to one decimal place (see Note 2 in Table 4 of F01).

2-3 Sampling for HMA Aggregates (S12)

2-3.1 Sample Size (S12)

A set of two samples of each aggregate component, each with masses ranging from 2 to 25 kg (see Table 7 of S12) shall be taken by the Contractor, for each sublot in accordance with the Sampling subsection of S12. The QA laboratory will use one sample from each set to combine one portion of each aggregate component together, according to the proportions specified in the mix design. The combined sample will then be split on the 4.75 mm sieve and QA testing will be performed on the coarse and fine portions of the combined sample. The other sample from each set for each aggregate component will be stored by the QA laboratory for possible referee testing.

2-3.2 Sampling Frequency (S12)

During HMA production, the Contractor is required to take a set of two samples of HMA, and each aggregate identified in the mix design (see section 2-3.1), from every lot of 20,000 tonnes of HMA mix produced (for payment by square metre Contracts use the formula in section 2-4.2.1 to convert tonnages to square metres). A set of two samples of RAP and RST may also be required at the Regional Quality Assurance Section's discretion. Sampling **of each aggregate identified in the mix design** will be performed at the HMA plant from the individual stockpiles according to the Stockpile Method clause of S12 or from the aggregate source.

A set of two samples of HMA and each aggregate component shall be taken; each set of two samples should be delivered to the QA laboratory without marked designation or they could be marked "1" and "2". The Contract Administrator or the QA laboratory will choose one of the two for QA testing and retain the other for referee testing, if required. The Aggregate Sample Data Sheet (PH-D-10) must accompany the samples.

2-4 Sampling for Mix and Volumetric Properties (F01)

2-4.1 Sample Size (F01)

For all Superpave and SMA mixes, a set of two samples, each with masses of 20 to 45 kg (see Table 2 in F01) shall be taken by the Contractor, for each sublot (see Note 2-1, Note 2-2, and Note 2-3) in accordance with the Sampling subsection of F01. The QA laboratory will perform QA testing on one sample and the other sample will be stored for possible referee testing. For SMA, two additional 3 to 5 kg samples will also be required (possibly another plate, if plate samples are being taken) from one of the sublots in each lot for QA and possible referee "draindown" testing (see Table 2 in F01). For Warm Mix Asphalt (WMA), two additional 50 kg samples will be required from three sublots per mix type for "moisture sensitivity" testing for information purposes only (see Table 2 in F01).

Note 2-1: Although plate sampling of Superpave and SMA mixes is one of the methods that can be used, it is not recommended, as the larger samples required for gyratory testing means that at least twice as many plates will be needed as was formerly required for Marshall mixes. In addition, it is permitted to split the material at the paving site such that a sample is contained in a maximum of two receptacles and it **is** not mandatory to mix them once they are received at the testing laboratory **therefore** each receptacle **must be** representative.

Note 2-2: The larger sample size will be applicable when samples are designated for testing to the maximum number of gyrations. The frequency of the larger samples shall be one per lot, as designated by the Contract Administrator (see Table 4 in F01).

Note 2-3: An exception to these requirements may be made if lightweight aggregates are used.

2-4.2 Sampling Frequency (F01)

The sampling frequency is dependent on the lot size with the sublot size being set at the Contract Administrator's discretion in consultation with the Contractor within the parameters given in the Lot Size clause and Table 3 of F01 (see section 2-9 for guidance on setting up lot and sublot sizes).

When a lot is defined as 5,000 tonnes of any one type of HMA produced, then the lot will normally be divided into ten approximately equal sublots of 500 tonnes each.

The Contractor may obtain one sample for Quality Control (QC) purposes at the same time and location that QA samples are taken. No additional loose mix samples shall be taken from the placed HMA.

2-4.2.1 Sampling Frequency for Square Metre Items (F01)

In Payment by Square Metre (PSM) Contracts, the lots used for the acceptance of mix and volumetric properties will also be based on area in square metres. However, if the Contract does not already refer to a quantity in square metres, the theoretical HMA quantity in square metres will be used to replace the "tonnage" references in the Contract Documents. Table 3 in F01 provides a breakdown of the tender item quantity into lots based on either a lift thickness of 40 to 50 mm or 60 to 80 mm. If the thickness does not fall into one of these categories, the tonnes per lot can be converted to square metres based on a formula (shown in the Tonne to Square Metre Conversion clause of F01 and below).

What would normally be a 5,000 tonne lot, designed at 40 to 50 mm in thickness, will be a 40,000 m^2 lot for most End Result Specification (ERS) sampling. In addition, as in other Contracts, lots will normally be divided into ten sublots. So, in this scenario, an average sublot would be 4,000 m^2 in size.

Using the approach described above, the Contract Administrator will be able to design the lot/sublot system using the same methods described in section 2-9 by substituting the stated tonnages with areas based on the design thickness of the relevant lift and the relevant quantities given in Table 3 of F01 or using the following formula from F01:

$$Q_A = Q_t / [0.975 \times BRD_{MD} \times (T_D/1000)]$$

Where:

BRD_{MD} = the bulk relative density in t/m^3, provided in the mix design submitted for mix, the Q_A is calculated for
T_D = the design thickness, in millimetres, of the mix
Q_t = non-payment tonnage quantity referred to elsewhere in the Contract Document for the mix under the measurement by square metre item
Q_A = theoretical square metre quantity (rounded to the nearest whole metre) to replace the non-payment tonnage quantity referenced elsewhere in the Contract Documents

Example: 50 mm of Superpave 19.0 overlain by 50 mm of Superpave 12.5 was placed in two lanes (East/West) of 3.75 m in width between Sta. 22+245 and Sta. 25+195.

Determine the sublots for both lots (i.e. mix types) as follows:

Total Area of placement: (25+195 - 22+245) x 3.75 x 2(lanes) = 22,125 m^2

Since a typical sublot is 4,000 m^2 for a 40 to 50 mm lift, this would represent about six sublots. In accordance with the Lot Size clause of the Mix Properties and Compaction clause of F01, the HMA placed in this circumstance (i.e. three to nine sublots) should be considered as one lot.

Analogous to the example shown in section 2-9.3 of this Field Guide, for a lot, which is greater than 8,000 m^2 but less than 40,000 m^2, the total area of placement should be evenly divided into six sublots, as follows:

Sublot	1	22 + 245	-	23 + 228.3	}	**Eastbound**
	2	23 + 228.3	-	24 + 211.7	}	
	3	24 + 211.7	-	25 + 195	}	
	4	25 + 195	-	24 + 211.7	}	**Westbound**
	5	24 + 211.7	-	23 + 228.3	}	
	6	23 + 228.3	-	22 + 245	}	

2-4.3 Sampling Methods and Random Sample Locations

Random samples are to be obtained by the methods permitted in the Contract. Refer to the Contract Documents to determine which method is permitted for each HMA type. The methods which may be permitted include loose mix sampling (diverted from the exit stream of the material transfer vehicle (MTV), taken from the screed auger chamber of the paver, or plate samples) or any acceptable alternative sampling method proposed by the Contractor as long as each sample is taken after its designated truckload has been unloaded at the site and each sample is representative.

Note 2-4: Although plate sampling is a loose mix sampling method, it is not recommended since plate samples are taken from the placed mat, which requires proper reinstatement. The other methods mentioned above are recommended as they are taken prior to placement and do not affect the finished mat.

The sampling locations and lot/sublot sizes should be determined on a daily basis (see section 2-9 for guidance on setting up lots and sublot sizes). They cannot be determined at the start of a Contract on a tonnage or square metre basis because there may be a need to terminate a lot prior to reaching a pre-determined tonnage or area.

2-4.3.1 Quantity Method for Loose Mix Samples (F01)

1. When production is expected to proceed with 5,000 tonnes lots with ten sublots, divide each lot as follows:

Example: Superpave 12.5 to have a set of two 20 to 45 kg samples obtained from each 500 tonne sublot within a 5,000 tonne lot, i.e. Lot 3.

Lot 3	Sublot	1	0	-	$\leq$ 500 t
		2	$>$ 500	-	$\leq$ 1,000 t
		3	$>$ 1,000	-	$\leq$ 1,500 t
		4	$>$ 1,500	-	$\leq$ 2,000 t
		5	$>$ 2,000	-	$\leq$ 2,500 t
		6	$>$ 2,500	-	$\leq$ 3,000 t
		7	$>$ 3,000	-	$\leq$ 3,500 t
		8	$>$ 3,500	-	$\leq$ 4,000 t
		9	$>$ 4,000	-	$\leq$ 4,500 t
		10	$>$ 4,500	-	$\leq$ 5,000 t

2. For each sublot, either select a random number from a random number table or generated by a calculator or computer. A table of random numbers is given in Appendix A: Random Number Table.

Lot 3	Sublot 1	0.750
	Sublot 2	0.446
	etc.	etc.

3. Using the random number determined for each sublot, identify the "tonne to be sampled". In reality, this number is only used to identify the truckload from which the sample is to be taken.

   Example: random number x lot or sublot size = tonne to be sampled

   0.750 x 500 = 375

4. Set up a table with each tonne to be sampled as follows:

Superpave 12.5: Sampling Locations (Set of two 20 - 45 kg samples) – 5,000 tonne Lots

Superpave 12.5 Lot/Sublot No.	Sublot Size	Random No. for Tonne	"Tonne to be Sampled" =(Random No. X 500) + start tonne for sublot
3/1	0 - ≤500 t	0.750	375
3/2	>500 - ≤1,000 t	0.446	723
3/3	>1,000 - ≤1,500 t	etc.	etc.
3/4	>1,500 - ≤2,000 t	etc.	etc.
3/5	>2,000 - ≤2,500 t	etc.	etc.
3/6	>2,500 - ≤3,000 t	etc.	etc.
3/7	>3,000 - ≤3,500 t	etc.	etc.
3/8	>3,500 - ≤4,000 t	etc.	etc.
3/9	>4,000 - ≤4,500 t	etc.	etc.
3/10	>4,500 - ≤5,000 t	etc.	etc.

Note 2-5: DO NOT PROVIDE THE SAMPLE TONNE INFORMATION TO THE CONTRACTOR BEFORE THE TRUCK, CONTAINING THE TONNE TO BE SAMPLED, IS LOADED.

5. A copy of the sample table is provided to the road inspector, designated by the Contract Administrator, who will be responsible for identifying the truckload containing the sample tonne. A running total of HMA production will have to be maintained for each item. A printing calculator or adding machine will minimize any chance of error. When the truck containing the "tonne to be sampled" is identified, the road inspector must:

   a) Mark the top of the weigh ticket "load to be sampled".

   b) Write on the back of the ticket the mass of the sample, the lot number, and sublot number (where applicable).

      Example: Mass 20 kg
      Lot 3
      Sublot 1

   c) Draw a diagonal line across the face of the ticket with a bright coloured marking pen. This will help draw attention to the fact that the load is to be sampled.

6. When the load is received at the MTV/paver, the road inspector must ensure that the Contractor's representative is fully aware and ready to take the sample anywhere within the load.

7. The Contractor's representative is then required to take the set of two samples (for SMA and Superpave mixes, two or more plates per sample will be required, if plate samples are being taken – i.e. see Table 2 in F01 and Notes 1 and 2 anywhere within the load (but recommended within the middle third of the load).

8. All samples shall be taken from the same truckload (and for plate samples at the same transverse offset and at least 1 m and no more than 3 m from one another).

9. Plate samples shall only be obtained from a machine laid mat, away from the wheelpaths of the paving equipment and far enough away from any pavement edge to ensure that the whole plate is covered by the mat.

10. For each set of two samples, one sample should be labelled "1" and the other "2" for QA and possible referee testing.

11. The Bituminous Mix and Core Sample Identification form (PH-CC-139) must accompany the samples.

12. The samples should then be delivered to the designated location, as detailed in the Contract.

13. For plate samples, after the paver has passed over each plate, examine the pavement surface. If the pavement surface is found to be homogeneous, then the set of samples is acceptable, providing that the samples on each of the plates (four or more plates for SMA and Superpave mixes i.e. see Table 2 in F01 and Notes 1 and 2 have a minimum mass of 10 kg. However, if the pavement sample is disturbed, in some way, or if any one of the plate samples has less than 10 kg, then the Contractor must discard the set of plate samples and obtain a new set of two (i.e. four or more plates in total for SMA and Superpave mixes – see Table 2 in F01 and Notes 1 and 2 as soon as possible. In all cases, ensure that the full thickness of the pavement has been obtained on the plate.

14. Immediately after a plate sample is taken, the Contractor must fill the holes with HMA. The same mix type as was sampled should be used to fill the hole. The holes must be filled in such a way as to conform with the adjoining undisturbed pavement. If the mat where the plate samples were taken is not reinstated correctly and is deemed, by visual appearance, to be deficient material or work, the deficient material or work should be removed and replaced.

Note 2-6: The size of the plate, if plate sampling is used, may be changed according to mat thickness, in order to yield a minimum of 10 kg. For example, for a lift 40 mm thick, a plate with minimum dimensions of 0.35 x 0.35 m (14 x 14 in.) is required to obtain 10 kg of mix. For different mat thicknesses, refer to Table 2-1:

Table 2-1: Approximate Mass of Superpave 12.5 on Plate (kg)

MAT THICKNESS (mm)	PLATE SIZE					
	.15 x .20	.25 x .25	.30 x .30	.35 x .35	.45 x .45	m
	6 x 8	10 x 10	12 x 12	14 x 14	18 x 18	in
100	6.7	14.0	20.2	27.5	45.5	
80	5.4	11.2	16.2	22.0	36.4	
70	4.7	9.8	14.1	19.3	31.8	
60	4.0	8.4	12.1	16.5	27.3	
50	3.3	7.0	10.1	13.7	22.7	
40	2.7	5.6	8.1	11.0	18.2	
30	2.0	4.2	6.0	8.2	13.6	
25	1.7	3.5	5.1	6.9	11.4	

2-4.3.2 Random Sample Locations for Square Metre Items (F01)

In each sublot, the locations of sampling for mix and volumetric properties and compaction testing will be determined in a similar fashion to the methods described in section 2-4.3.1 and 2-5. For the example given in section 2-4.2.1, the sampling locations would be determined as follows:

1. Select a random number for each sublot, from a random number table (Appendix A:) or generated by a calculator or computer.

   Example: Sublot 1 - 0.886,
   2 - 0.234,
   etc. etc.

2. For each sublot, determine the station for sampling using the selected random number.

   Example: Sublot 1 random # x length of sublot = Distance into sublot.
   0.886 x 983.3 = 871.2 m metres or
   Sta. 22+245 + 871.2 = Sta. 23+116.2

   For Sublot 1, a set of two samples will be taken @ Sta. 23+116.

   Sublot 2 random # x length of sublot = Distance into sublot.
   0.234 x 983.4 = 230.1 m metres or
   Sta. 23+228.3 + 230.1 = Sta. 23+458.4

   For Sublot 2, a set of two samples will be taken @ Sta. 23+458.

   etc. etc.

Note 2-7: DO NOT PROVIDE THE STATION INFORMATION TO THE CONTRACTOR BEFORE THE TRUCK CONTAINING THE LOAD TO BE SAMPLED IS LOADED.

3. The Contract Administrator should advise the Contractor, approximately one hour prior to the paver reaching the identified sampling station.

4. For each sublot, all samples shall be taken at the identified sampling station +/- 3 m.

5. The sampling method, the sizes (i.e. weights) and the packaging and labelling of the samples will be similar to the methods described in sections 2-4.3.1 and 2-5.

2-5 Core Sampling for Compaction Testing (F01)

In accordance with the Contract requirements and the Compaction clause under the Sampling subsection of F01, core samples for compaction testing are based on the same lots and sublots defined for mix and volumetric properties (see section 2-4), except that compaction cores shall not be taken on bridge decks.

The Contractor may obtain one sample for QC purposes at the same time and location that QA samples are taken. If the Contractor wishes to obtain additional QC core samples, a maximum of three cores (a combination of compaction or thickness cores for a maximum total of three cores) in each surface lot and one core from each sublot of binder course prior to paving the surface course may be taken. Cores shall not be spaced closer than 1.0 m from any other core. Further additional samples shall only be taken upon written consent of the Contract Administrator in accordance with the Quality Control subsection of F01. All sample locations shall be restored as given in step 12 below.

For each 500 tonne sublot, a randomly selected location will be chosen for a set of two cores taken by the Contractor.

1. The locations for the set of two cores are determined by selecting pairs of random numbers from a random number table (see Appendix A: Random Number Table). The first number will be used to calculate the distance into the sublot and the second for the offset of the core in accordance with the following example:

   Example: Superpave 19.0 to have a set of two cores obtained from each 500 tonne sublot within a 5,000 tonne lot (Lot 3).

   5000 tonnes of Superpave 19.0 was placed between Sta. 22+245 and Sta. 35+495 over a 3.75 metre width (i.e. one lane).

   Length of Lot 3: 22+245 - 35+495 = 13,250 metres
   Length of sublots: 13250 ÷ 10 = 1,325 metres

Lot 3	Sublot	1	22 + 245	-	23 + 570
		2	23 + 570	-	24 + 895
		3	24 + 895	-	26 + 220
		4	26 + 220	-	27 + 545
		5	27 + 545	-	28 + 870
		6	28 + 870	-	30 + 195
		7	30 + 195	-	31 + 520
		8	31 + 520	-	32 + 845
		9	32 + 845	-	34 + 170
		10	34 + 170	-	35 + 495

2. From a random number table (see Appendix A: Random Number Table) or generated by a calculator or computer, select pairs of numbers for each sublot.

Example:	Lot 3	Sublot	1	0.235,	0.713
			2	0.732,	0.030
			etc.	etc.	etc.

3. Using the first number of each pair, determine the longitudinal location of the cores, and using the second number from each pair, determine the transverse location.

Example:	Lot 3	1st random # x length of sublot	=	Distance into lot
	Sublot 1	0.235 x 1325	=	311.4 m or
		Sta. 22+245 + 311.4	=	Sta. 22+556.4
		2nd random # x pavement lane width for the lot	=	offset Rt. EP
		0.713 x 3.75	=	2.69 m

Lot 3, set of two cores @ Sta. 22+556.4 offset 2.69 m Right of the Edge of Pavement (EP).

4. DO NOT GIVE THE CONTRACTOR THE LOCATION OF THE CORES UNTIL ROLLING OF THE LOT IS COMPLETE (see Note 2-8).

5. The Contractor must extract the cores no later than the next regular Working Day following the completion of each sublot. However, if it is desired to obtain the cores immediately after the completion of the sublot, then the Contractor must demonstrate to the Contract Administrator that the pavement can be made sufficiently cool (by using dry ice, for example) prior to coring.

6. If the core location falls less than 250 mm from an unconfined pavement edge, then the cores are to be relocated a distance of 250 mm from the edge of the lane. Coring on bridge decks will not be allowed, unless permitted by the Contract Administrator and cores cannot be taken within 250 mm of a longitudinal or transverse joint, or the edge of pavement.

7. The set of two cores must be taken from the same lane, at the same transverse offset, and within a spacing of 1.0 ± 0.1 m from one another.

8. The cores must have a minimum diameter of 150 mm and a maximum nominal diameter of 200 mm and must consist of the full layer being sampled and at least one underlying layer, if one is present. All cores (including those taken for possible referee testing), should be inspected for defects. If a core is damaged, a replacement core must be extracted at a location adjacent to the original core.

9. Clearly mark, on each core, all relevant information including its Contract number, lot, sublot, and label the top of the core “TOP” using a permanent metallic paint marker. Silver (or gold) markers appear to produce the best results and may be obtained at any well-stocked art supply store (see Note 2-9). For each set of two cores, one of the cores shall be for QA testing and one for possible referee testing. The two cores should be delivered to the QA laboratory without marked designation or they could be marked “1” and “2”. The Contract Administrator or the QA laboratory will choose one of the two for QA testing and retain the other for referee testing, if required.

10. The integrity of all cores must be protected during transport and until the testing is carried out. One method that the Contractor could use to protect the cores is to first individually wrap each core in cellophane or similar material (see Note 2-10), place it in a metal or plastic cylinder (such as the type used for casting concrete cylinders) and the void between the core and cylinder wall could be filled with fine sand to prevent movement of the core within the cylinder.

11. The Bituminous Mix and Core Sample Identification form (PH-CC-139) must accompany the samples. To provide additional protection to the cores, the heavy gauge bags containing the samples could be placed in small cardboard or metal boxes and surrounded by appropriate packaging material (bubble wrap or newspaper could be used for this purpose).

12. Immediately after coring, the Contractor must clean out and sponge dry all core holes; fill them with HMA; and compact the HMA according to the Compaction clause under the Sampling subsection of F01. A mechanical compactor with a round foot slightly smaller than the diameter of the core hole must be used. The holes must be filled and compacted in such a way as to conform with the adjoining undisturbed pavement. The same mix type as was sampled should be used to fill the hole; however, when approved by the Contract Administrator, any surface course mix may be used.

13. The Contract Administrator must ensure that all cores have been obtained at their proper locations (i.e. chosen from pairs of random numbers as in 2 and 3 given above) and that all of the core holes have been properly filled.

14. Once any cores have been received, the QA laboratory should inspect them for damage and any undamaged cores should then be carefully re-packaged. However, if any of the cores have been damaged, then the Contract Administrator should be immediately notified.

Note 2-8: When a core location coincides with a localized area which has been identified by the Contractor prior to paving and determined by the Contract Administrator to be unable to provide adequate support for the Contractor's compaction operations (and consequently result in lower compaction), then the core shall be moved to the nearest location outside of the area identified. It should be noted that these locations shall not be identified by the Contractor after the compaction core has been taken or after the compaction test result(s) have been received.

Note 2-9: Two types of paint markers that the Bituminous Section have found to be suitable include the Sanford, silver coat, bold tip metallic and the Pilot Paint Marker, Bullet Tip. Both are about $6.00 each. Any well-stocked art supply store should have similar products.

Note 2-10: It should be noted that when a core contains more than one lift of HMA and the bond between the lifts breaks during coring or at any time prior to being wrapped for transport, then each lift within the core shall be clearly marked with all appropriate information. In addition, the separated lifts should be individually wrapped before being placed in the plastic or metal container.

2-6 Core Sampling for Lift Thickness (F01)

2-6.1 Sample Size (F01)

In accordance with the Contract requirements and the Lift Thickness clause under the Sampling subsection of F01, for HMA items measured in square metres, the Contractor shall obtain one thickness core sample (with a nominal diameter of 50 mm and consisting of the full layer being

sampled and at least one underlying layer) from each sublot to be designated as the sublot thickness core sample.

The Contractor may obtain one sample for QC purposes at the same time and location that QA samples are taken. If the Contractor wishes to obtain additional QC samples, a maximum of three cores (a combination of compaction or thickness cores for a maximum total of three cores) in each surface lot and one core from each sublot of binder course prior to paving the surface course. Cores shall not be spaced closer than 1.0 m from any other core. Further additional samples shall only be taken upon written consent of the Contract Administrator in accordance with the Quality Control subsection of F01. All sample locations shall be restored as given in section 2-5 (step 12).

2-6.2 Sampling Frequency (F01)

The Contract Administrator shall determine the size and location of the lots and sublots after discussion with the Contractor and before HMA production for the item starts. A lot for thickness acceptance will generally consist of the total pavement quantity for each HMA square metre tender item.

Each lot shall be divided into sublots approximately 2,000 m^2 in size. A minimum of three sublots are required for each lot. All lifts below the surface course will have the same sublot numbers and the same start and end points as the surface course. Separate sublots should be used to assess paved shoulders greater than 1.0 m in width (do not take samples in paved shoulders less than or equal to 1.0 m, but include the shoulder quantity in the lane sublots). An example is given below:

Example: 50 mm of Superpave 19.0 overlain by 50 mm of Superpave 12.5 was placed in two lanes (East/West) of 3.75 m in width and 50 mm of Superpave 12.5 was placed in two shoulders (East/West) of 2.50 m in width between Sta. 22+245 and Sta. 25+195.

Determine the sublots for both lots (i.e. mix types) as follows:

Total area in the lanes: (25+195 - 22+245) X 3.75 X 2(lanes) = 22,125 m²
Total area in the shoulders: (25+195 - 22+245) X 2.50 X 2(shoulders) = 14,750 m^2

Length of each sublot in the lanes: 2000 ÷ 3.75 m = 533 m (rounded to nearest m)
Length of each sublot in the shoulders: 2000 ÷ 2.50 m = 800 m

Sublots in the lanes (for the lot of 50 mm Superpave 12.5 and the lot of 50 mm Superpave 19.0):

1	22 + 245 -	22 + 778		**Eastbound**
2	22 + 778 -	23 + 311		
3	23 + 311 -	23 + 844		
4	23 + 844 -	24 + 377		
5	24 + 377 -	24 + 910		
6	24 + 910 -	25 + 195	(1068.75 m²)	
6	25 + 195 -	24 + 947	(930 m²)	**Westbound**
7	24 + 947 -	24 + 414		
8	24 + 414 -	23 + 881		
9	23 + 881 -	23 + 348		
10	23 + 348 -	22 + 815		
11	22 + 815 -	22 + 245	(2137.5 m^2)	

Sublots in the shoulders (for the lot of 50 mm Superpave 12.5)

12	22 + 245 -	23 + 045		
13	23 + 045 -	23 + 845		
14	23 + 845 -	24 + 645		**Eastbound**
15	24 + 645 -	25 + 195	(1352.5 m²)	
15	25 + 195 -	24 + 936	(647.5 m²)	
16	24 + 936 -	24 + 136		
17	24 + 136 -	23 + 336		
18	23 + 336 -	22 + 536		
19	22 + 536 -	22 + 245	(727.5 m^2)	**Westbound**

If the 50 mm Superpave 12.5 shoulders were only 0.50 m in width in the above example, then only sublots 1 to 11 would be sampled in the lanes, (i.e., no samples taken in the 0.50 m partially paved shoulders), but the test results for the lift thickness of the surface course would apply to the partially paved shoulders too. The sublots for the surface course would increase from 2000 m^2 to: sublot length X lane width including shoulder = 533 X 4.25 = 2265.25 m^2. Any payment adjustment would be applied to this new sublot area instead of 2000 m^2.

2-6.3 Sampling Method and Random Sample Locations (F01)

Within each sublot, sampling for thickness will be carried out in a similar fashion to core sampling for compaction testing. As shown in section 2-5, within each sublot, a pair of random numbers will be used to generate the offset from the edge of lane and the longitudinal distance from the beginning of the sublot to the sampling point. However, unlike compaction, only one core will be required at each location for measurement by the QA laboratory since the same core can be re-measured at a different QA laboratory than the one that made the first QA measurement, if the Contractor decides to challenge that measurement. Continuing the example given in section 2-6.2 as follows:

1. From a random number table (Appendix A:) or generated by a calculator or computer, select pairs of numbers for each sublot.

Example:	Sublot	1	0.235,	0.713
		2	0.732,	0.030
		etc.	etc.	etc.

2. Using the first number of each pair, determine the station of the core, and using the second number from each pair, determine its transverse location.

Example:	Sublot 1	1st random # x length of sublot	=	Distance into sublot.
		0.235 x 533	=	125.3 m or
		Sta. 22+245 + 125	=	Sta. 22+370 EB
		2nd random # x pavement lane width for the lot		
		0.713 x 3.75	=	2.69 m offset Right from Edge of Pavement (EP)

For Sublot 1, a core will be taken @ Sta. 22+370 in the EB lane offset 2.69 m Rt. EP

Sublot 2	1st random # x length of sublot	=	Distance into sublot.
	0.732 x 533	=	390.2 m or
	Sta. 22+778 + 390	=	Sta. 23+168 EB
	2nd random # x pavement lane width for the lot		
	0.030 x 3.75	=	0.11 m offset Rt from EP

For Sublot 2, a core will be taken @ Sta. 23+168 in the EB lane offset 0.11 Rt. EP

etc. etc.

3. The cores will then be labelled and packaged as given in section 2-5, except that every one will be labelled QA and include the number of lifts required for thickness measurement identified by mix type and lift number. Top of cores shall be labelled "TOP". The Bituminous Mix and Core Sample Identification form (PH-CC-139) must accompany the samples.

4. If the core location falls less than 250 mm from an unconfined pavement edge, then the cores are to be relocated a distance of 250 mm from the edge of the lane. Coring on bridge decks will not be allowed, unless permitted by the Contract Administrator and cores cannot be taken within 250 mm of a longitudinal or transverse joint, or the edge of pavement.

5. Each core shall have a nominal diameter of 50 mm and shall consist of the full layer being sampled and at least one underlying layer. Each core shall have its vertical side cored perpendicular to the upper surface of the core. No replacement surface course thickness cores shall be obtained for QA or referee testing. When a new core is requested due to the core thickness being reported as "indeterminate" or damaged, a new 150 mm nominal diameter core shall be taken centred over the sublot's previously taken 50 mm core.

Note 2-11: All areas of HMA, including paved shoulders, within the Contract limits should be sampled for lift thickness with the following exceptions:

a) Detours and other temporary pavement;
b) Miscellaneous hot mix asphalt;
c) Bridge decks;
d) Paved shoulders less than 1.0 m wide; and
e) Additional stations and/or roadways as detailed in the Contract.

It should be noted that extra exempt locations shall not be identified by the Contractor after the core has been taken or after the test result(s) have been received.

Note 2-12: It should be noted that when a core contains more than one lift of HMA and the bond between the lifts breaks during coring or at any time prior to being wrapped for transport, then each lift within the core shall be clearly marked with all appropriate information. In addition, the separated lifts should be individually wrapped before being placed in the plastic or metal container.

2-7 Sampling for SMA Coated Gritting Materials (NSSP)

2-7.1 Sample Size (NSSP)

In accordance with the Contract requirements and the Sampling and Testing subsection of the Non-Standard Special Provision for the item Gritting of Stone Mastic Asphalt, each day during the SMA gritting operation the Contractor shall obtain a single 5 kg sample of the **coated** gritting material from the roller hopper and submit the sample to the **QA laboratory** for testing.

Upon completion of the SMA gritting operation, five core samples (with a diameter of 150 mm) of the gritted SMA shall be taken from random locations, in addition to any taken for QA purposes **and should be delivered to the MERO Bituminous laboratory**.

2-7.2 Sampling Frequency (NSSP)

The Contract Administrator shall determine the place and time of the sampling in consultation with the Contractor.

1. The cores cannot be taken within 250 mm of an unconfined pavement edge. Coring on bridge decks will not be allowed, unless permitted by the Contract Administrator and cores cannot be taken within 250 mm of a longitudinal or transverse joint, or the edge of pavement.

2. The cores must have a minimum diameter of 150 mm and a maximum nominal diameter of 200 mm and must consist of the full layer of SMA being sampled and at least one underlying layer, if one is present. All cores should be inspected for defects. If a core is damaged, a replacement core must be extracted at a location adjacent to the original core.

3. The integrity of all cores must be protected during transport and until the testing is carried out. One method that the Contractor could use to protect the cores is to first individually wrap each core in cellophane or similar material (see Note 2-10), place it in a metal or plastic cylinder (such as the type used for casting concrete cylinders) and the void between the core and cylinder wall filled with fine sand to prevent movement or the core within the cylinder.

4. The five **cores** should be well wrapped (e.g. in bubble wrap or newspaper) and the Bituminous Mix and Core Sample Identification form (PH-CC-139) must accompany the samples. To provide additional protection to the cores, the heavy gauge bags containing the samples could be placed in small cardboard or metal boxes and surrounded by appropriate packaging material (again, more bubble wrap or newspaper could be used for this purpose).

5. Immediately after coring, the Contractor must clean out and sponge dry all core holes, fill them with SMA, and compact the SMA according to the Compaction clause under the Sampling subsection of F01. A mechanical compactor with a round foot slightly smaller than the diameter of the core hole must be used. The holes must be filled and compacted in such a way as to conform with the adjoining undisturbed pavement. When approved by the Contract Administrator, any surface course mix may be used to fill the hole.

6. The Contract Administrator must ensure that all cores have been obtained at their proper locations and that all of the core holes have been properly filled.

7. Once all five cores have been received, the core samples should be delivered to the **MERO** Bituminous laboratory at:

   145 Sir William Hearst Avenue
   Downsview, Ontario M3M **0B6**
   Room 15

2-8 Sampling for PGAC (1101 & F09)

Sampling requirements for PGAC are as per Table 2 of 1101. To ensure that the PGAC being sampled and tested is representative of the material used in production, it is recommended that samples (cans) taken at the HMA plant be taken from the storage tank or tanker that is directly feeding the production of the HMA. PGAC SAMPLES SHALL *NOT* BE TAKEN FROM A TANKER THAT IS DELIVERING PGAC TO THE ASPHALT PLANT.

In accordance with the Contract requirements and 1101, the total tender quantities of HMA items should be divided into lots for PGAC sampling purposes, in accordance with the following:

a) < 10,000 tonnes: One lot

b) ≥ 10,000 tonnes: Each 10,000 tonnes will be treated as one lot. If the last lot has less than 5,000 tonnes, then it will be added to the previous lot. However, if it is greater than or equal to 5,000 tonnes but less than 10,000 tonnes, then it will be treated as a separate lot.

The Contractor is required to take four 1-litre samples (cans) of PGAC (two 1-litre samples for QA and two 1-litre samples for possible referee testing) which are randomly chosen within each lot. In addition, the Contractor is required to take one 4-litre sample (or four 1-litre samples) of PGAC (for possible Owner testing) from the first lot of each grade and source of PGAC used on the Contract.

Note 2-13: Instead of four 1-litre cans for the QA and possible referee testing samples, two cans able to hold a minimum of 2-litres (i.e. two 4-litre cans half-filled) is also acceptable.

An example of random sampling for PGAC is given below:

1. When 27,750 tonnes of HMA production is expected, PGAC sampling shall proceed as follows:

   Example: Superpave 12.5FC 1 to have a set of four 1-litre samples (cans) obtained from each 10,000 tonne lot (i.e. Lots 1 to 3) and one 4-litre sample from Lot 1.

Lot 1	0	to	≤ 10,000 t
Lot 2	> 10,000	to	≤ 20,000 t
Lot 3	> 20,000	to	≤ 27,750 t

2. For each lot, the Contract Administrator either must select a random number from a random number table or generated by a calculator or computer. A table of random numbers is given in Appendix A: Random Number Table.

Lot 1	0.872
Lot 2	0.125
Lot 3	0.465

3. Using the random number determined for each lot, the Contract Administrator will identify the "tonne to be sampled".

Example: random number x lot size		= tonne to be sampled
0.872 x 10,000	=	8,720
0.125 x 10,000	=	1,250
0.465 x 7,750	=	3,604

4. The Contract Administrator will then set up a table with each tonne to be sampled as follows:

Superpave 12.5FC 1: Sampling Locations (Set of four 1-litre samples) – 10,000 t Lots

Superpave 12.5FC 1 Lot No.	Lot Size	Random No. for Tonne	"Tonne to be Sampled" =(Random No. X 10,000) + start tonne for lot
1	0 - ≤ 10,000 t	0.872	8,720
2	>10,000- ≤ 20,000 t	0.125	11,250
3	> 20,000 - ≤ 27,750 t	0.465	23,604

5. The Contractor will then take four 1-litre sampling cans (or two sampling cans able to hold a minimum of 2-litres each) of the PGAC which will be used in the "tonne to be sampled". The Contractor will also take an additional 4-litre sampling can (or four 1-litre sampling cans) of the PGAC from the first lot of each grade and source at the first sampling location of each lot. The samples are taken near the point of injection into the mix (usually a spigot on the PGAC supply line).

6. After the samples have been taken, the Contractor should put a lid on each sample (can) and the Contract Administrator must immediately take possession of the QA and referee samples (for testing by the QA laboratory) as well as the one 4-litre sample for possible Owner testing (to be delivered to the Bituminous Laboratory). Since the samples will be hot, the Contract Administrator should take the samples to a location (such as the Contract Administrator's office) which will allow them to cool sufficiently in order that they can be bagged.

7. For each set of four 1-litre samples, the four samples should be delivered to the QA laboratory without marked designation or they could be marked "1", "2", "3", and "4". The Contract Administrator or the QA laboratory will choose two of the four for QA testing and retain the other two for referee testing, if required. If two 4-litre cans are used, one could be labelled "1" and the other "2".

8. Once they are cooled, the samples can be inserted into the same type of heavy gauge plastic bag that the Regional QA Section provides for HMA. The one 4-litre sample for possible Owner testing should be inserted into a separate heavy gauge plastic bag and labelled "AAT". Packing material should be placed around the cans to try to keep them upright and so that they do not knock against one another and become uncovered. The Bituminous Material Product Sample Form (PH-CC-349) must accompany the samples.

9. Once sealed, the QA and referee samples must be delivered to the QA laboratory. The one 4-litre sample for possible Owner testing must be delivered within seven Days to the **MERO** Bituminous laboratory at:

   145 Sir William Hearst Avenue
   Downsview, Ontario M3M **0B6**
   Room 15

2-9 Guidance on Setting up Lots and Sublots (F01)

The lot sizes for HMA will be set at the Contract Administrator's discretion, in consultation with the Contractor. However, when the tender item quantity is 5,000 tonnes or more, the lot size for mix and volumetric properties and compaction testing will normally be 5,000 tonnes with ten equal sublots of 500 tonnes each. The number of lots **should** be chosen in accordance with the guidelines given in Table 3 of F01, entitled "Breakdown of the Tender Item Quantity into Lots for

Mix Properties and Compaction". Interruptions during paving and tender items with smaller quantities than 5,000 tonnes will be dealt with, as detailed in F01 and this section.

If the item overruns, the planned lot size should be continued, taking random samples as required until the item is completed. After the samples for the last complete lot have been taken, the additional sublots should be treated in the same manner as for an interrupted lot, as shown in section 0.

2-9.1 Paving on Bridge Decks and Staged Construction - All Item Quantities (F01)

The quality of HMA on bridge decks is a major concern to the Ministry because of the severe consequences which can result from substandard material. To address this concern, the Contract Administrator, in conjunction with the Regional Quality Assurance Section, should treat HMA placed on a bridge deck or placed in staged construction separately, with each stage as a separate lot. However, multiple stages paved within 20 Business Days can be considered as one lot at the discretion of the Contract Administrator. The Contract Administrator should also consider including paving of the approaches to a bridge as part of these lots.

To determine the amount of testing that will be required for that lot; the Contract Administrator must consider the consequences of accepting substandard material **and** the amount of material to be placed. The Contract Administrator may also want to consider the quality of HMA that was produced to date using that particular job mix formula.

2-9.1.1 Bridge Decks and Construction Stages Greater than 100 Tonnes (F01)

When a bridge deck or any construction stage is <u>greater than 100 tonnes</u>, it is suggested that the lot be divided into three approximately equal sublots; each with one set of two loose mix samples (see Table 2 of F01 and Notes 1 and 2 for the sample size and frequency) at each sampling location. Test all three sublots and apply the results to the ERS system outlined in F01 and chapter 3. Core samples shall not be taken on bridge decks.

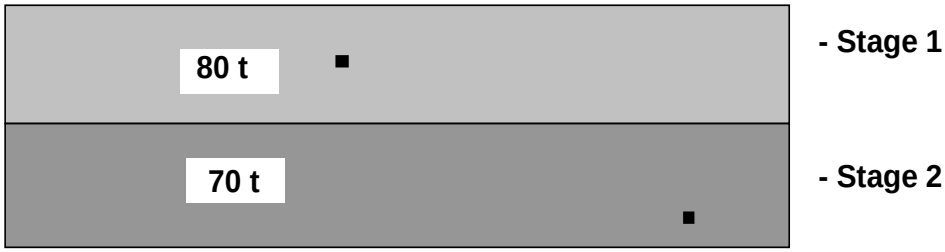
2-9.1.2 Bridge Decks and Construction Stages Less than 100 Tonnes (F01)

When a bridge deck or any construction stage is <u>less than 100 tonnes,</u> it is suggested that the lot be either a lot with a single sublot, or divided into three approximately equal sublots as determined by the Contract Administrator in consultation with the Contractor.

If a lot with a single sublot is selected, take one random set of two samples (see Table 2 of F01 and Notes 1 and 2 for sample size and frequency) and treat the lot as a small quantity lot for acceptance and payment (see section 2-9.5). Core samples shall not be taken on bridge decks.

If the Contract Administrator selects three equal sublots, follow the procedure in section 2-9.1.1 for Bridge Decks and Construction Stages Greater than 100 Tonnes.

Example: Construction Stages Less than 100 Tonnes - Single Sublot Option Selected



1. Take one set of two samples for a particular stage.
2. One of the two samples is tested for acceptance and compare to the criteria outlined in Table 5 of F01.
3. If non-rejectable and the VMA is no more than 0.50% below the design minimum – assign a payment factor of 1.000.
4. If rejectable or the VMA is more than 0.50% below the design minimum – remove and replace or allow to remain in the work with a payment adjustment according to the Small Quantity Lots clause in F01.

2-9.2 Item Quantity Greater than 5,000 Tonnes (F01)

When the surface HMA tender item quantity for Superpave or SMA mixes is 5,000 tonnes or more, it will be permitted to have one optional trial lot not exceeding 500 tonnes and consisting of one sublot. This 500 tonne lot must be placed in a binder course in lifts no thicker than 60 mm (if the Contract is single lift construction, it must be placed in the surface course) and not in a critical location such as a bridge deck and may even be deferred to the next construction season. However, it must never be used to retroactively reduce price adjustments. The optional trial lot will be treated as a small quantity lot for acceptance and payment (see section 2-9.5).

The remaining quantity of the tender item will normally be divided into 5,000 tonne lots, each with 10 equal sublots of 500 tonnes each. Various ways of planning the location of these lots are shown in the examples (in the following pages).

The quantity remaining after paving the last full lot will normally be treated as follows:

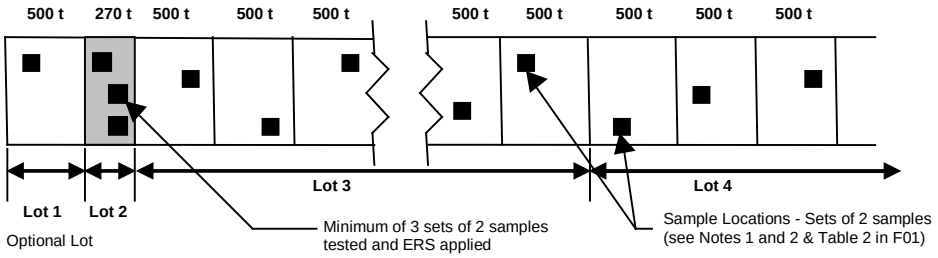
a) If the remaining quantity is expected to be less than 1,000 tonnes, consider it as part of the previous lot.

b) If the remaining quantity is expected to be greater than 1,000 tonnes, then the Contractor may request that the remaining quantity be considered as a separate lot with a minimum of three sublots.

Examples of the application of the ERS system when the item is greater than 5,000 tonnes are as follows:

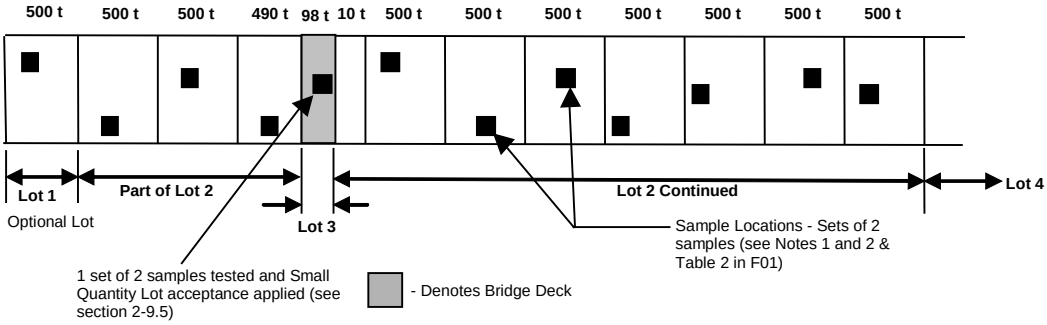
Paving Bridge Decks - Item Quantity = 15,000 tonnes

Example 1 - Bridge Deck Quantity > 100 t (Paved Near Start of Contract)

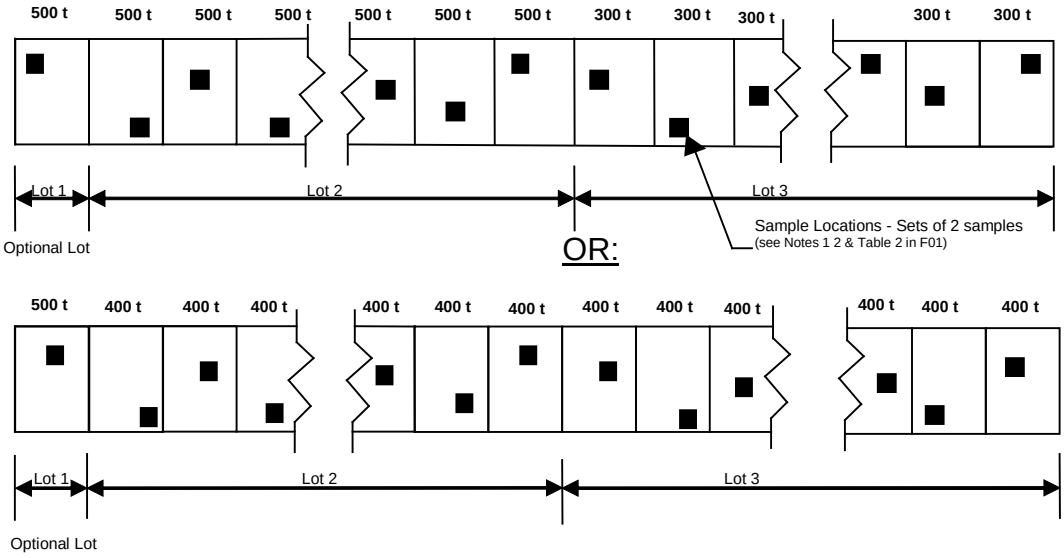


OR:

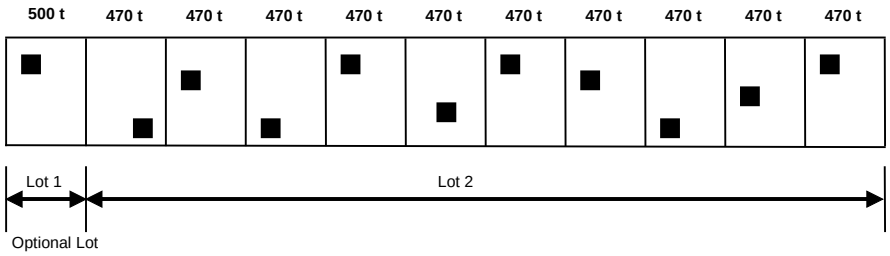
Example 2 - Bridge Deck Quantity < 100 t (Paved Near the Middle of Contract)



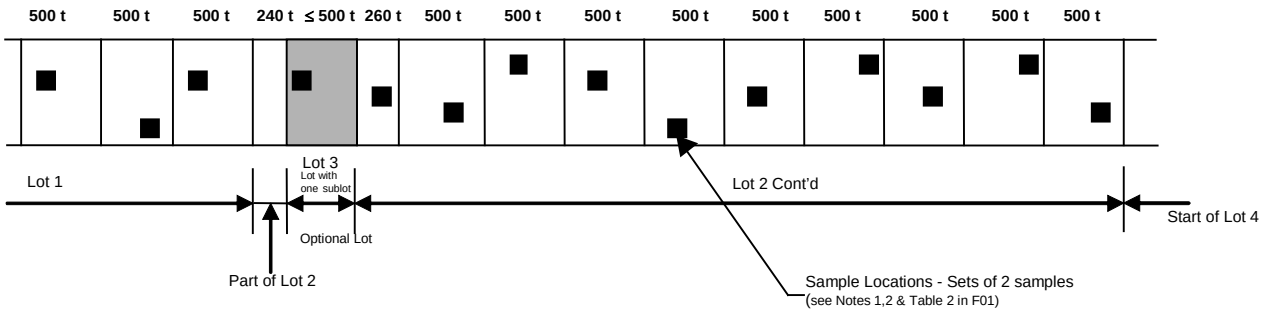
Example: **Item Quantity = 8,500 t**



Example: **Item Quantity = 5,200 t**



Example: **Item Quantity > 5,000 t**



When only one or two sublots are completed at the end of the paving item, due to a change in the job mix formula or when a delay of more than 20 Days occurs in placing the complete lot, then the test results obtained for the one or two sublots will be considered as part of the previous lot and the previous lot will then have 11 or 12 sublots. When three to nine sublots are completed due to the above circumstances, then the three to nine sublots will be considered as a lot. However, when a delay of more than 20 Days occurs in placing the complete lot, prior to the end of the 20 Days, at the Contractor's request in writing to the Contract Administrator, the lot may be completed upon the resumption of paving for that item.

Example: <u>Interrupted sequence of paving due to unforeseen stoppage or change in Job Mix Formula</u>

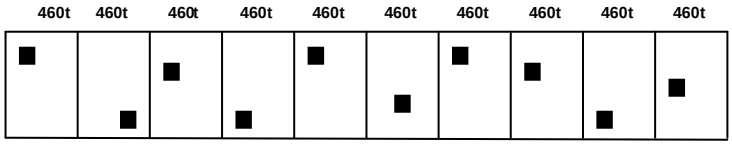
Note 2-14: The last 200 tonnes shown in the diagram (referred to by the "?") would be a sublot if, by random numbers, a sample was required to be taken. Regardless of whether or not a sample is to be taken, the 200 tonnes is included in the total quantity of the previous lot.

2-9.3 Item Quantity 1,000 Tonnes to 5,000 Tonnes (F01)

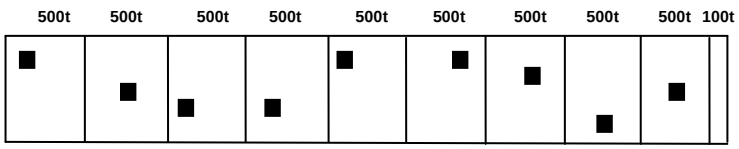
When the tender item quantity is between 1,000 tonnes and 5,000 tonnes, the quantity will normally be considered as one lot. The lot/sublot sizes can be reduced at the discretion of the Contract Administrator and after discussion with the Contractor. If possible, the sublot sizes should be of equal size. A minimum of three sublots have to be completed and tested to constitute a lot in order that the ERS system may be used.

An example of the use of the testing regime to be used is as follows:

Example: <u>Item Quantity = 4,600 t</u>



<u>NOT</u>



2-9.4 Item Quantity Less than 1,000 Tonnes (F01)

When the item quantity is less than 1,000 tonnes, the lot/sublot sizes will be determined by the Contract Administrator based on individual circumstances. For item quantities less than 1,000 tonnes, the HMA may be accepted by the Contract Administrator based upon such testing as is deemed necessary by the Contract Administrator to determine substantial conformance with the Contract. When three or more tests have been completed, for a lot, the material will be accepted at the full Contract price, subjected to a payment reduction, or rejected, as detailed in F01.

The amount of testing to be performed on a lot will depend on the consequences of accepting substandard material, the amount of material to be placed and the constraints (location and workload) of the QA Laboratory.

2-9.5 Small Quantity Lots (Lots Comprised of 1 or 2 Sublots) (F01)

Any lot comprised of only one or two sublots, shall not be subject to a payment adjustment unless the mix is rejectable. Each sublot will be accepted or rejected separately. A sublot is acceptable if the AC content, gradation, air voids, and compaction (compaction does not apply to bridge decks) complies with the limits in Table 5 of F01 and the VMA is no more than 0.50% below the design minimum. Any individual sublot, in a lot of only one or two sublots, shall be rejectable if it does not comply with these requirements and shall be administered as described in the Repairs for Mix Properties and Compaction clause of F01. If a rejectable sublot is allowed to remain in the work, apply a payment adjustment according to the Small Quantity Lots clause in the Basis of Payment section of F01.

Example: A lot of Superpave 12.5 with only two sublots:

Sublot 1: Test Results	Acceptance Criteria	Accept/ Reject
AC Content = 4.65	JMF - 0.40 to JMF + 0.50 (4.4 to 5.3)	Acceptable
DLS Sieve = 80.7	JMF - 5.0 to JMF + 5.0 (79.4 to 89.4)	Acceptable
4.75 Sieve = 56.0	JMF - 5.0 to JMF + 5.0 (54.5 to 64.5)	Acceptable
75 Sieve = 4.4	JMF - 2.0 to JMF +2.0 (2.1 to 6.1)	Acceptable
Air Voids = 4.3	2.5 to 5.5	Acceptable
Compaction = 95.2	91.5 to 98.0	Acceptable
VMA = 13.6	> min VMA -0.5% (> 13.5)	Acceptable

Sublot 1 is acceptable since all of the test results for the sublot comply with the limits in Table 5 of F01 and the VMA is more than 0.5% below the design minimum. Therefore, the sublot 1 would be assigned a PF_{MC} = 1.000, resulting in no payment adjustment for sublot 1.

Sublot 2: Test Results	Acceptance Criteria	Accept/ Reject
AC Content = 4.3	JMF - 0.40 to JMF + 0.50 (4.4 to 5.3)	Rejectable
DLS Sieve = 80.7	JMF - 5.0 to JMF + 5.0 (79.4 to 89.4)	Acceptable
4.75 Sieve = 65.6	JMF - 5.0 to JMF + 5.0 (54.5 to 64.5)	Rejectable
75 Sieve = 4.4	JMF - 2.0 to JMF +2.0 (2.1 to 6.1)	Acceptable
Air Voids = 4.3	2.5 to 5.5	Acceptable
Compaction = 95.2	91.5 to 98.0	Acceptable
VMA = 13.6	> min VMA -0.5% (> 13.5)	Acceptable

Sublot 2 is rejectable since AC content and the 4.75 sieve test results for the sublot do not comply with the limits in Table 5 of F01. Therefore, sublot 2 would be subject to repair. If it is allowed to remain in the work a PF of 1.000 would apply to all the acceptable attributes and a PF corresponding to PWL = 50% (25% for each sieve) would apply to all rejectable attributes as follows:

PF_{AC} = 0.700
PF_{DLS} = 1.000
$PF_{4.75}$ = 0.450
PF_{75} = 1.000
PF_{AV} = 1.000
PF_{C} = 1.000
PF_{VMA} = 1.000

Then PF_{MC} is calculated for the sublot using the formulae in the Calculations clause of F01 as follows:

$PF_{G\ (SUB)} = PF_{DLS} + PF_{4.75} + PF_{75}$
$PF_{G\ (SUB)} = 1.000 + 0.450 + 1.000$
$PF_{G(SUB)} = 2.450 < 3$ then
$PF_{G} = 2.450 / 3 = 0.8167$

$PF_{GAC(SUB)} = PF_{G} + PF_{AC}$
$PF_{GAC(SUB)} = 0.8167 + 0.700$
$PF_{GAC(SUB)} = 1.5167 < 2$ then
$PF_{GAC} = 1.5167 / 2 = 0.7584$

$PF_{VMA} = 1.000$, therefore:
$PF_{VOIDS} = PF_{AV} = 1.000$

$PF_{M(SUB)} = PF_{GAC} + PF_{VOIDS}$
$PF_{M(SUB)} = 0.7584 + 1.000$
$PF_{M(SUB)} = 1.7584 < 2$ then
$PF_{M} = 1.7584 / 2 = 0.8792$

$PF_{MC(SUB)} = PF_{C} + PF_{M}$
$PF_{MC(SUB)} = 1.000 + 0.8792$
$PF_{MC(SUB)} = 1.8792 < 2$ then
$PF_{MC} = 1.8792 / 2 = 0.9396$

PF_{MC} = 0.9396 would be applied to the sublot 2 quantity for a payment adjustment calculated using the formula in the Payment Adjustment for Mix Properties and Compaction clause of F01.

Chapter Three

REPORTING HOT MIX ASPHALT TEST RESULTS

3-1 General (F01)

This chapter has been prepared for reporting test results on Contracts with an End Result Specification (ERS) for the acceptance of Hot Mix Asphalt (HMA) based on gradation, Asphalt Cement (AC) content, air voids, Voids in Mineral Aggregate (VMA), compaction, and lift thickness (if the item is measured in square metres). In addition, this chapter also covers the reporting of additional Performance Graded Asphalt Cement (PGAC) test results. For reporting smoothness, results see chapter 6. As in chapter 1, Special Provision 103F01 that deletes and replaces OPSS.PROV 313 will be referred to as "F01" for the purposes of this Field Guide.

The ERS system requires that the test results from a minimum of three sublots be used to determine the acceptability of a lot with the exception of small quantity lots (lots comprised of only one or two sublots) such as the optional trial lot, which is allowed for an item with greater than 5,000 tonnes (see section 0 and 2-9.5).

The Owner will conduct tests, carry out calculations, and provide values according to Table 4 of F01. Quality Assurance (QA) testing shall be used for assessing the acceptability of HMA. The Contract Administrator will provide the Contractor with a copy of the completed test results as per the Acceptance Testing clause of F01.

Three spreadsheets are available from the Ministry's Registry, Appraisal, and Qualification System (RAQS) at www.raqs.merx.com or from the appropriate Regional QA Section as listed below:

ERS - Hot Mix Asphalt Pay Factor Calculation Form PH-CC-868_103F01 "ERS **2016** – Hot Mix Asphalt Pay Factor Calculation."

ERS – Thickness Payment Adjustment Calculation Form PH-CC-869 "ERS - Thickness Payment Adjustment Calculation."

PGAC Test Reporting Sheet Form PH-CC-250 "PGAC Test Reporting Sheet."

Ensure the latest version of the spreadsheet that applies to the applicable Contract Documents is used. Always start with a fresh spreadsheet as entries from previous use could have over written cell formulas. This chapter will assist the Contract Administrator in comparing the QA and/or referee test results, in order to assess the conformance of HMA to the Contract specifications for the required attributes. In addition, it will assist the Contract Administrator in filling out the PGAC Test Reporting Sheet.

3-2 Conventions for Saving and Naming of Files

It is suggested that the original copy of the template be kept as a backup file and a template-based separate data file be created for each lot and saved under an appropriate unique name. A separate folder should be created for each mix type, containing the files of all lots of that mix type. Another folder should be created for each paving Contract which contains all of the folders for the individual mix types.

A typical file name should consist of up to 22 characters followed by the standard ®Excel extension of .xls (i.e. *2015-3002_SMA095_03.xls or 2015-2138_SUP125FC2_15.xls*). The first nine (usually) characters (i.e. *2015-3002* or *2015-2138*) will represent the Contract number. An underscore ("_") should then separate the next three to nine characters (*i.e. SMA095 or SUP125FC2*) which represent the mix type, designated in accordance with the recommended codes given in section 1-2.1. A second underscore ("_") will follow the mix type, which is then followed by the last two characters before the extension, which identifies the lot number (i.e. 03 for lot three, 15 for lot 15).

The use of this convention for the naming of files will assist the Owner's staff when tracking results from many different Contracts. *ALL* files/folders must be forwarded to the applicable Regional Quality Assurance Section at the completion of each lot.

Questions regarding the program or the inputting of data should be addressed with the appropriate Regional Quality Assurance Officer.

3-3 Reporting Mix Properties and Compaction (F01)

The test results from the mix properties and compaction testing for each sublot are used to determine a combined payment factor. For lots with three or more sublots, a computer program has been developed to calculate the combined payment adjustment based on all applicable attributes (see section 3-3.1).

3-3.1 ERS - Hot Mix Asphalt Pay Factor Calculation Spreadsheet (F01)

In order to automate the calculations for the various test results, the Bituminous Section has developed an Excel spreadsheet computer program; based on QA tests for acceptance. An example of a filled out FIN tab from the spreadsheet is provided in section 5-5 and an example of a filled out QA tab is provided at the end of this chapter.

Note 3-1: Macros have been removed to help with email submissions.

In the spreadsheet, the pay factor can only be calculated for lots with three or more sublots.

The following tab names are used to navigate among the various worksheets:

TAB NAME	SHEET
Guide	Basic User Information
QA	QA LOT PAY FACTOR CALCULATION Sheet
REF	Referee LOT PAY FACTOR CALCULATION Sheet
AddData	Additional Attributes/Requirements Record Sheet
OutC	TEST FOR OUTLIER Calculation Sheet
FIN	FINAL Composite Pay Factor Calculation Sheet
App	Appendix (supporting statistical tables etc.)

To *Move* within any individual worksheet, you can use the scroll bars shown or the arrow keys (←↑→↓). The PgDn, PgUp, Alt+PgDn, Alt+PgUp, may also be used to move one screen down, up, to the right, or to the left.

DATA INPUT:

The workbook and all individual sheets are password protected so that the formulae cannot be accidentally altered or erased. Areas where data is to be input are unprotected and shaded blue or yellow for better clarity. Although the cells are fully editable (including the format), the format of the cells should not be edited or changed by the user. For partial QA, the data is simply entered in the appropriate numbered sublot row on the QA sheet.

The following number of significant digits should be used for data entry and rounded in accordance with LS-100 (i.e. Appendix B: LS-100 Method for Rounding Off of Data and Other Numbers):

To the Nearest Whole Number:	Thickness
To One Decimal Place:	Individual (% passing) gradation results Individual percent compaction results Air void values VCA_{drc}, VCA_{mix} (for SMA) VFA Dust Proportion G_{mm} at N_{ini} and N_{max} Tensile Strength Ratio
To Two Decimal Places:	AC content VMA Draindown
To Three Decimal Places:	Core BRD Loose Mix MRD Loose Mix BRD

If any technical difficulties are encountered with the program, please contact:

Ministry of Transportation,
Bituminous Section,
Materials Engineering and Research Office,
Room 238
145 Sir William Hearst Avenue
Downsview, Ontario M3M **0B6**

Telephone: (416) 235-**3715**
Email: bituminous@ontario.ca

It is strongly recommended that the lot data file name be established (i.e. rename the file with the mix type and lot number as detailed in section 3-2 before entering data) and that all input data is frequently saved.

The rest of this section includes general instructions for the use of the Excel Program.

1. The 'QA' sheet is used to enter the general Contract information and QA test results. The general Contract information is input at the top of the sheet and will automatically be

repeated on the 'REF', 'AddData', and 'FIN' sheets. The Region, Mix Type, Mix Designation, and course can be selected from drop-down menus. Make sure to select the units as either tonnes or m^2 from the drop down menu in cell C6. To the right of "MIX TYPE", one of the recommended codes should be used (or click on cell B8, and choose one of the recommended codes for the mix type from the drop down menu). See section 1-2.1 for a list of the recommended codes.

Note 3-2: Red font indicates a required field has not been entered. As soon as the required information is entered, the font will change to black.

The Job Mix Formula (JMF) designation number (JMF Id.) is placed in cell A13 and the JMF data in cells B13 to E13 and H13. The QA test data should be input into the blue-shaded areas of the 'Sublot Data Input' table. The sublot test results are to be entered in cells B14 to H25, for the Designated Large Sieve, 4.75 mm sieve, 75 μm sieve, AC Content, Air Voids, Compaction, and VMA (the 600 μm sieve was removed in F01). In addition, the mean combined aggregate density should be entered in cell I9 and if a JMF adjustment that applies to this lot resulted in lowering the design AC content then "Yes" should be selected from the drop down menu in cell I11; otherwise "No" should be selected. The User will also be required to input the design thickness in cell I6. For RBM, a box will appear in cell I7 for inputting the design air voids. The rest of the sheet displays the lot calculation results and the intermediate and final pay factors. The Total Pay Factor (PF_{MC}) represents the final calculation. All of the information at the top of the sheet (in red font) must be entered in order to see the final pay factor (PF_{MC}).

2. The 'REF' Sheet should be used only to input referee test results when referee testing has been invoked for one sublot, two sublots, or all of the sublots. The name of the referee laboratory should be entered in cell H7 and the date of referee testing in cell D9. Sublot referee results for mix attributes (gradation, AC content, air voids, and VMA) and/or the results for compaction are to be entered in some or all of the cells B14 to H25, depending on which properties were referee tested. The rest of the sheet displays lot calculation results and calculates the intermediate and final pay factors. The final calculations are for the total pay factor "PF_{MC}". If only one or two sublots were referee tested, then the pay factor (PF_{MC}) will not be displayed on this tab, but the FIN tab will replace the QA results with the referee results for the sublots that were referee tested to show the final pay factor (PF_{MC}). The REF tab will say "See FIN Tab" if the whole lot was not tested for referee.

3. The 'AddData' Sheet includes other contractual information such as sampling location, thicknesses, BRD's etc. The Contract requirements for layer thicknesses, core and loose mix MRD's and BRD's, VMA, G_{mm} at N_{ini} and G_{mm} at N_{max} are input in the appropriate cells in row 15. The QA test results (and REF for draindown) are input into the appropriate cells E17 to AA28 as required. Appropriate columns are displayed for data entry when a specific mix type is selected on the "QA" page.

4. The 'OutC' Sheet is used to check any group of sublot test results for outliers. Enter the number of sublots in cell D3, the suspected outlier result in cell D4 and the other sublot results for the specific characteristic/property in the cells below cell D4. The outcome of the statistical test will be displayed in cell H5. For comparison, answers for three different significance levels (0.5%, 1.0%, and 2.5%) are provided.

5. The 'FIN' Sheet is to be used to confirm the final payment factor for combined mix properties and compaction (PF_{MC}). The FIN sheet automatically transfers any test results from the QA sheet and then replaces any QA results with test results that have been input into the REF sheet. The FIN sheet automatically calculates the final pay factor at the bottom of the page in the cell to the right of PF_{MC} (cell E45). Ensure that no unnecessary data has been entered in the REF sheet and all required information has been entered on the QA sheet to get the

final payment factor. The recommended conventions for the saving and naming of files are given in section 3-2.

3-3.2 Using the Spreadsheet for Square Metre Items (F01)

The spreadsheet described above, may be used for payment by square metre Contracts except that on the QA tab, the lot size should be input into cell D6 in m^2, instead of tonnes (t) and "lot size (m^2)" should be selected from the drop down menu in cell C6. Everything else will remain the same.

3-4 Reporting Lift Thickness Test Results (F01)

The lift thickness measurements shall be determined based on lift thickness of the single pavement core sample for each sublot as determined by the QA laboratory according to LS-294. If the Contractor requests referee testing, the same single pavement core sample will be tested at an alternate QA laboratory.

The Contract Administrator shall provide the Contractor with a copy of each lift thickness measurement upon completion of the sublot measurement (PH-CC-870). The lift thickness measurements shall be reported in millimetres to the closest 0.5 mm. The rounding-off procedure, for all values, shall be according to LS-100. A computer program has been developed to calculate the payment adjustment based on lift thickness (see section 3-4.1).

3-4.1 ERS – Thickness Payment Adjustment Calculation Spreadsheet (F01)

A spreadsheet entitled "ERS - Thickness Payment Adjustment Calculation" (PH-CC-869) is to be used to assist the Contract Administrator with the payment adjustment calculations for Contracts with HMA items measured by the square metre. An example of a completed ERS Thickness Payment Adjustment Calculation spreadsheet is provided at the end of this chapter.

As in other ERS spreadsheets, the detailed instructions are included in the "Guide" page.

1. In the "Payment Adjustment" page, the surface course mix is chosen using the drop-down menu in cell C12 and the applicable binder courses (up to 6 of them) in cells D12 to I12.

2. After the User inputs the "# of Sublots" (in cell E7) for the surface course and presses Enter. The User can adjust the number of rows as follows: left click on the button entitled "*Press This Button to Add Rows or Remove Unwanted Rows Before Printing.*" Adjusting the number of rows needed to input the data will impact the number printed on the calculation sheet too. The User will have to wait a few moments for this adjustment to take place.

3. The spreadsheet also assumes each sublot to be 2,000 m^2. However, for any sublots that are not 2,000 m^2, the User can substitute the correct area in the appropriate cell. Note that this will overwrite the formula in that cell.

4. Input the design thicknesses (row 13), tender prices (row 1**6**), and the appropriate thickness measurements. Once these are entered, the spreadsheet will calculate the thickness penalty for each item, and the overall penalty for the Contract will be shown at the bottom of the table (cell C32**5**).

   Note 3-3: The Tender Opening Date Reduction Factor (TODRF) has been removed from the spreadsheet, as it no longer applies to lift thickness.

3-5 Reporting PGAC Test Results

A spreadsheet entitled “PGAC Test Reporting Sheet” is to be used to assist the Contract Administrator with the reporting and acceptance of additional PGAC tests as outlined in section 5-2.4.1. The laboratory will enter the information in the blue coloured cell, and then the Contract Administrator should only enter information in the orange coloured cells (the acceptance limits and the meets requirements columns). The Contract Administrator should refer to the Contract Documents to determine the limits (acceptance criteria) and if the test results are acceptable, minor borderline, major borderline, rejectable, or for information purposes only. Actions to take, if any, can be found in the Contract Documents (normally 1101 as amended by F09). An example PGAC Test Reporting Sheet (PH-CC-250) can be found at the end of this chapter.

All PGAC test results must be e-mailed to the Bituminous Section at the following address: bituminous@ontario.ca.

ERS 2016 - Hot Mix Asphalt Pay Factor Calculation

QA LOT PAY FACTOR CALCULATION

February 2016 Version

CONTRACT	2015-XXXX	Lot No.	4
HIGHWAY	X	Lot Size (m2)	4000
REGION	N-Eastern	No. Sublots	10
MIX TYPE	**SUP125**	Date Paved	05-Jul-16
MIX DESIGNATION	Warm Mix	Date Tested	05-Jul-16
ITEM No.	3	% RAP Content	10

Course: Surface

Design Thickness: 40

Combined Aggregate Density: 2.655

Did a JMF adjustment to this lot result in a decrease in the design %AC? No

Sublot Data Input

JMF Id.	DLS	4.75 mm	75 µm	AC Content	Air Voids	Compaction	VMA
2015-XXX-XXX	**73.5**	**51.8**	**3.8**	**4.6**			**14.0**
Sublot 1	78.9	54.5	3.9	4.37	4.2	94.6	15.05
Sublot 2	76.3	55.9	4.1	4.27	4.0	92.8	14.84
Sublot 3	76.3	54.1	1.9	4.37	4.0	93.0	14.56
Sublot 4	69.9	45.3	3.7	4.15	4.3	93.5	14.90
Sublot 5	77.7	54.7	4.2	4.39	3.8	92.3	14.75
Sublot 6	73.1	50.7	4.1	4.30	3.8	92.8	13.90
Sublot 7	78.7	55.1	2.8	4.79	3.7	92.3	13.85
Sublot 8	78.0	57.3	4.4	4.39	2.8	92.6	14.45
Sublot 9	76.1	54.8	4.4	4.43	3.7	92.5	14.70
Sublot 10	68.8	46.9	3.1	4.11	4.6	94.5	14.22
Sublot 11							
Sublot 12							

Lot Calculation Results

COUNT	10	10	10	10	10	10	10
Lot Mean	75.4	52.9	3.7	4.4	3.9	93.1	14.5
Std Dev	3.60	3.98	0.82	0.19	0.48	0.85	0.41
LL	68.5	46.8	1.8	4.2	2.5	91.5	
UL	78.5	56.8	5.8	5.1	5.5	97.0	
QL	1.92	1.53	2.32	1.05	2.92	1.88	
QU	0.86	0.98	2.56	3.68	3.33	4.59	
PL	99	95	100	86	100	99	
PU	81	84	100	100	100	100	
PWL	80	79	100	86	100	99	
PF	0.9860	0.9830	1.0034	1.000	1.020	1.024	1.000

Calculation of Total Pay Factor

$PF_{G(SUB)}$ =	2.9724
PF_{G} =	0.9908
$PF_{GAC(SUB)}$ =	1.9908
PF_{GAC} =	0.9954
PF_{VOIDS} =	1.0200

$PF_{M(SUB)}$ =	2.0154
PF_{M} =	1.0154
$PF_{MC(SUB)}$ =	2.0394
PF_{MC} =	**1.0394**

Ministry Rep. Signature _____ Contractor Rep. Signature _____

Date: _____ Date: _____

Comments: _____

_____

_____

Copy to: Regional Quality Assurance Contract Administrator Contractor Originator

PH-CC-868_103F01_FEB16_Example

March 2016 Thickness ERS - Payment Adjustment Calculation

CONTRACT	2015-XXXX	LOT NO.	8
HIGHWAY	X		
REGION	Eastern	# OF SUBLOTS (max 300 sublots)	15

Press This Button to Add Rows or Remove Unwanted Rows Before Printing

		Surface Course	Binder and Other Courses				
	Mix Type	SUP125FC1					
	Design Thickness (mm)	40					
	Minimum Thickness (mm)	30					
	Item No.	9					
	Price*	13.70					
Sublot #	Sublot Area (m^2)	Core Thickness	Core Thickness	Core Thickness	Core Thickness	Core Thickness	Core Thickness
1	2000	45.5					
2	2000	47					
3	2000	41					
4	2000	39					
5	2000	29					
6	2000	44					
7	2000	37.5					
8	2000	32					
9	2000	41.5					
10	2000	35.5					
11	2000	40					
12	2000	42					
13	2000	37					
14	2000	37.5					
15	2000	41					

* Price is the Contract price of the hot mix asphalt surface course tender item.

** Cells shown in Red shall be repaired and the thickness retested at the discretion of the Contract Admi

Thickness Calculation Results

COUNT	15	0	0	0	0	0
Lot Mean Thickness	39.3	0.0	0.0	0.0	0.0	0.0
TL	39.3	0.0	0.0	0.0	0.0	0.0
Penalty for Inadequate Thickness	14385.00					
Total Lot Area	30000.00					
Total Penalty on the Contract For Inadequate Thickness	14385.00					

Ontario

PGAC Test Reporting Sheet

Contract No.:	2015-XXXX	**Region:**	West	**Date:**	5-Jul-16
Lab:	ABC Labs London	**PGAC Lot:** **HMA Lot:** **HMA sublot:**	1 3 2	**MSCR Test Temperature:**	58
Sample No.:	3900	**QA:** ☑ **Referee:** ☐			
PG Grade:	58 -34	**AC Supplier:**	Asphalt R US	**MSCR Traffic Grade (Note 1):**	S

Notes:

1. Leave MSCR Traffic Grade blank or as N/A and a S grade will apply, unless sample data sheet stipulates H, V or E.
2. The information at the top and the Results column (blue cells) are to be filled out by the Laboratory.
3. The Limits and Meets Requirements columns (orange cells) are to be filled out by the Contract Administrator according to the Contract Documents.
4. For PGAC compliance: Enter actual grade in cell G32 if choosing non-compliant. If compliant leave cell G32 blank.
5. Extended BBR: When LTLG does not meet the testing requirements, Contract Documents may specify using LTLG in place of Low Temperature Performance Grade to determine PG Compliance requirements of the Contract.
6. Ensure this form is accompanied by supporting documentation from the lab including: PGAC Compliance (AASHTO R29 documentation) and the latest DENT and Extended BBR reporting sheets as posted on RAQS.

PGAC Compliance	Results (Note 2)	Limits (Note 3)	Meets Requirements (Note 3)
Performance Grading (AASHTO R29):			
High Temperature Performance Grade	Compliant	>= 58	YES
Low Temperature Performance Grade	Non-Compliant (Note 4)	<= -34	NO
Enter Actual PGAC Grade (if non-compliant) (Note 4)	-32.5		
Ash Content (LS-227):			
Ash Content (%)	0.9	> 0.8 and <= 1.0	Major Borderline
Multiple Stress Creep Recovery (AASHTO T-350):			
Non-recoverable Creep Compliance at 3.2 kPa, $J_{nr3.2}$ (kPa^{-1})	2.05	< 4.5	YES
Average Percent Recovery at 3.2 kPa, $R_{3.2}$ (%)	69.2	> 24.3	YES
Difference Non-recoverable Creep Compliance, J_{nrdiff} (%)	29.7	N/A	N/A
Extended Bending Beam Rheometer (LS-308):			
Low Temperature Limiting Grade, LTLG (°C) (Note 5) (Note LTLG is the warmest Limiting Grade)	-28.4	N/A	N/A
T_{LBBR} (Limiting Grade for T+10°C at 1 hour)	-33.3	N/A	N/A
Grade Loss (°C)	4.9	N/A	N/A
Double Edge Notched Tension Test (LS-299):			
δ_t, CTOD, average (mm)	12.5	>= 14.0	Minor Borderline

Testing Technician:

PRINT NAME _____ SIGNATURE _____ DATE _____

Reviewed by:

PRINT NAME _____ SIGNATURE _____ DATE _____

PH-CC-250_SEP15

Chapter Four

ACCEPTANCE OF HOT MIX ASPHALT BASED ON VISUAL OBSERVATION

4-1 General

The purpose of this chapter is to provide guidelines for the acceptance of Hot Mix Asphalt (HMA) on the basis of visual observation. For the purposes of this chapter, Ontario Provincial Standard Specifications (OPSS) and Special Provisions will be referred to as detailed in section 1-1.

Visual deficiencies, other than segregation, are dealt with as "Other Pavement Surface Defects", as described in section 4-4.

Segregation, as well as all other visual deficiencies, should be dealt with as deficient workmanship, in accordance with the Performance Requirements for Quality Processes (Special Provision 199S53).

The Challenging Severity of Segregation clause of F01 (see section 4-4.1.4) is available for challenging the degree of severity for segregation that is encountered in certain Superpave mix types.

All Consultant Inspectors must be experienced in segregation assessment, prior to carrying out any visual inspection of the compacted HMA. It is recommended that at the beginning of the Contract, the Contract Administrator's Inspector work closely with the applicable Quality Assurance Officer so that consistent assessments are being made throughout the Province.

4-2 Temperature (F11 & F01)

As a guideline, if the temperature of the HMA once it arrives on the site has not lost more than 10°C (depending on haul distances) from the maximum discharge temperature specified for the HMA, then the Contract Administrator or a representative should visit the HMA plant to check that the discharge temperature meets the Contract requirements. The maximum temperature for all mixes specified in the Preparation of the Mixture subsection of F11 is 170°C.

The ambient air temperature must be at least 2°C to place HMA binder courses, and at least 7°C to place HMA surface courses.

HMA should not be placed over a previously laid course or opened to public traffic until the mat is 50°C or less. For HMA lifts ≤ 60 mm, measure the temperature at the surface, for HMA lifts > 60 mm, measure the temperature internally. Generally, the internal temperature will only need to be measured in situations where there are lane closure restrictions that prevent complete cooling. In these cases, a small hole can be drilled and a thermometer and water inserted to verify the temperature or the Contractor can install thermocouples during paving.

The Contractor may use water, ice, dry ice, or another approved method to cool the HMA as long as the pavement is dry and meets the Contract requirements prior to being paved over.

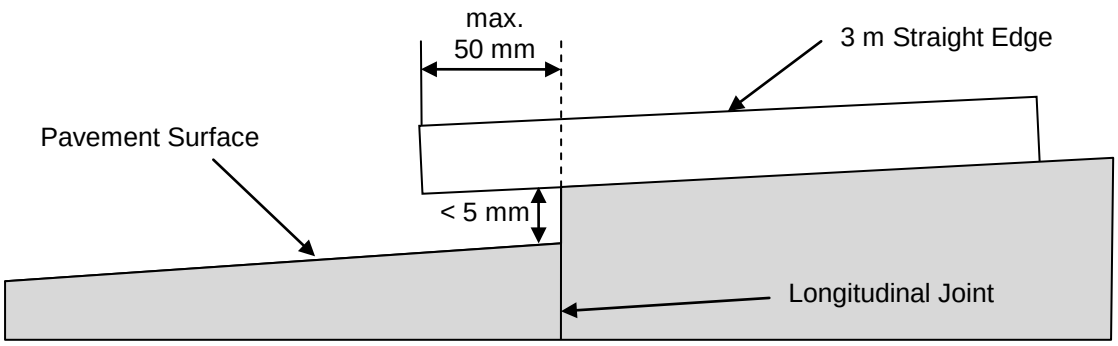
4-3 Acceptance of Surface Tolerance (F01)

Acceptance of surface tolerance will be in accordance with the Surface Tolerance clause of F01. If, by visual inspection, the longitudinal joint or pavement surface (including the edge of pavement, but not the crown or drainage gutters) appears uneven the Contract Administrator or a representative should test the surface tolerance with a 3 m straight edge at these locations.

When tested with a 3 m straight edge, there should not be a gap between the pavement surface and the bottom of the straight edge:

a) greater than 6 mm for all binder courses, levelling courses, and padding courses;
b) greater than 3 mm for all surface courses;
c) greater than 5 mm at longitudinal joints (see Figure 4-1).

Figure 4-1: Measuring Surface Tolerance of a Longitudinal Joint



Note 4-1: When measuring surface tolerance of a longitudinal joint, the elevation difference shall not exceed 5 mm. The straight edge should be placed on the higher pavement surface and not overhang the joint by more than 50 mm. Every effort should be made to measure the elevation difference flush with the joint face.

4-4 Acceptance of Surface Appearance (F01)

The Contract Administrator must ensure that the surface texture of the mat is of uniform texture and free of flushing, segregation (see section 4-4.1), fat spots (see Note 4-2), oil spills, surface damage, chatter (see Note 4-3), paver and roller marks, surface contamination, **cracking,** and any other surface defects. **Some examples are shown in Figure 4-2.**

Figure 4-2: Examples of Surface Defects

The Contract Administrator should verify any visually defective areas marked out by the **Contractor** on the pavement surface. The marks must remain in place until the pavement has been properly assessed and repaired, if necessary. The Inspector will be required to prepare a detailed list, which identifies each discrete area of defective pavement with its defect(s) and area in square metres.

Pavement may be deemed defective on the basis of visual observation, at any time before the end of the construction season in which the mix was placed. Such pavement must not be paved over until a decision is made as to its disposition. However, if the Contract Administrator deems that the pavement constitutes a hazard to the travelling public, then the hazard must be immediately eliminated.

All HMA deemed defective, on the basis of visual inspection, must be brought to the Contractor's attention, in writing, as soon as it becomes evident and should be dealt with, in accordance with the Performance Requirements for Quality Processes (Special Provision 199S53).

For causes other than segregation (e.g. “other pavement surface defects”), if the Contractor has not adequately dealt with defective pavement, in accordance with the requirements of Special Provision 199S53, then the Contract Administrator should:

1. Review the defective pavement; determine the quantity of HMA involved, the severity of the problem, the disposition of the area in question, and the responsibility for the cost for any remedial work, if required.
2. Discuss his/her findings and recommendations with the applicable Regional Quality Assurance Section (who may contact the Bituminous Section) prior to informing the Contractor.
3. Enforce the requirements of Special Provision 199S53 up to and including the issuing of deviation(s).

Note 4-2: A "draindown" test has been developed by AASHTO to indicate the likelihood that open-graded mixes (like Stone Mastic Asphalt) will form "fat spots". Any mix that has failed the 0.3% requirement for the draindown test (see section 5-2.2.1) should be brought to the attention of the Regional Quality Assurance Section. The Regional Quality Assurance Section and the Contract Administrator will determine if such areas require removal and replacement or if such areas can be accepted into the work with an extended warranty. An extended warranty will require monitoring during the warranty period by the appropriate Regional Quality Assurance Section and if "fat spots" develop later, then the Contractor may be required to remove and replace such areas.

Note 4-3: It should be noted that paver and/or roller marks might result in low-amplitude waves in the pavement, which can manifest themselves as vibrations in ride (commonly known as “chatter”). Experience with this phenomenon indicates that it appears to occur when a series of small amplitude regularly spaced waves have been constructed into the pavement surface. Such small waves would not normally be a problem, except that they are regularly spaced and appear to set up a vibration in certain vehicles passing over them. If the Contract contains the smoothness specification (Special Provision 103F31), such low-amplitude waves may not be reflected in surface smoothness measurements (i.e. a high profile index) but may be detected in ride quality. Since these waves appear to be caused by problems with the paver (e.g. a defective screed), the Contract Administrator should treat this phenomenon as he/she would any other problem associated with a defective paver, since there is often a definite visual textural deficiency associated with it.

4-4.1 Segregation (F01)

Segregation consists of areas with predominantly coarser or finer texture than that of the surrounding pavement. Segregation is classified as either “mid-lane segregation” or “other segregation” and its severity is defined as either “slight segregation”, “medium segregation”, or “severe segregation”, in accordance with the definitions given in F01.

4-4.1.1 Initial Notification / Corrective Action for Segregation (F01)

When the Contract Administrator first notices a segregation problem, (i.e. if the Contractor has not already identified the problem and proposed corrective action) then the Contract Administrator or designated representative must bring the problem to the Contractor's attention verbally and then immediately follow this up in writing with a letter to the Contractor. The Contractor must be instructed to take immediate preventative action, in order to preclude any reoccurrence of such segregation. The Contract Administrator must then ensure that the Performance Requirements for Quality Processes (Special Provision 199S53) are enforced (which may involve the assessment of a non-conformance deviation).

From the time notification is given of midlane segregation, a maximum of 500 tonnes may be placed to demonstrate the repairs or adjustments to the paver have eliminated the midlane segregation to the satisfaction of the Contract Administrator. If this is not accomplished within the 500 tonnes, the use of that paver will be discontinued. If medium or severe midlane or other segregation continues, follow section 4-4.1.3.

4-4.1.2 Disposition of Segregated Mix (F01)

Midlane Segregation occurring in HMA shall be dealt with as detailed below:

1. Slight Midlane Segregation:
   Slightly segregated mix will be accepted into the work with no payment reduction.

2. Medium and Severe Midlane Segregation:
   The Contract Administrator will determine if medium or severe midlane segregation will be assessed a payment reduction or repaired.

Other Segregation occurring in HMA shall be dealt with as detailed below:

1. Slight Other Segregation:
   Slightly segregated mix will be accepted into the work with no payment reduction.

2. Medium Other Segregation:

   a) Binder, Levelling, and Padding Courses
   Medium other segregation in levelling and padding courses with a total thickness greater than 40 mm (see Note 4-4), and all binder courses of any thickness, will normally be left in place with no payment reduction.

   However, any areas of medium other segregation that deteriorate prior to being overlaid by another pavement course must be repaired at no cost to the Owner (see Note 4-5).

   b) Surface Courses
   Medium other segregation in surface courses will normally be left in place with a payment reduction, or repaired at the discretion of the Contract Administrator.

3. Severe Other Segregation:
   All severely segregated mix must be repaired by removal and replacement.

   Note 4-4: Textural problems in levelling/padding courses with thicknesses less than a normal lift of HMA (i.e. less than 40 mm, in most cases), any bullnose, or tapers that were not machine-laid and any areas of “handwork” will be dealt with solely on the basis of their workmanship and not by segregation assessment.

   Note 4-5: When a binder course with medium other segregation will be open to traffic over the winter, the Contractor should be notified that the cost of any emergency repairs during the winter will be charged to the Contractor.

4-4.1.3 Continuing Segregation

When the Contractor has continuing problems with medium or severe segregation and the Contractor has not adequately dealt with (i.e. in accordance with the requirements of Special Provision 199S53), then the matter should be brought to the attention of the Quality Assurance Officer and/or Area Construction Engineer. The Owner may consider the possibility that factors beyond the Contractor's control such as experimental equipment or mix may be contributing to the problem. The Owner will then determine whether or not to instruct the Contractor to stop paving. If the Contractor is instructed to stop paving, the Owner will not be held responsible for any additional costs that the Contractor may incur as a result of the shutdown.

After instructing the Contractor to stop but before paving restarts, a special meeting should be held with the Contractor to emphasize the seriousness of the matter and the potential for further stoppages regardless of the Contractor's proposals to make repairs and/or agreement to payment reductions and/or the issuance of non-conformance deviations. The intent of the meeting is to prevent further placement of new pavement that will not perform as well as pavement placed without segregation. The meeting should be attended by the next level of management higher than the on-site supervisors for both the Owner and the Contractor, wherever possible. In some cases, these individuals should observe the pavement after restarting operations for themselves.

4-4.1.4 Challenging the Severity of Segregation (F01)

A mechanism for resolving challenges arising from differences in the assessment of the degree of severity (whether it is slight, medium, severe, or even non-existent) is described in the Challenging Severity of Segregation clause of F01. The Contractor must submit a written challenge within five Business Days of receiving the Owner’s first visual assessment including the dimensions and the Contractor’s assessment of the severity of each disputed area. For Contracts with up to 30,000 tonnes of HMA, the Contractor is allowed a maximum of two separate challenges per item and for Contracts with more; it is a maximum of four.

In addition, there is also a mechanism for resolving a challenge of the second visual assessment performed by the Owner for Superpave 12.5, Superpave 12.5FC 1, Superpave 12.5FC 2, Superpave 19.0, and Superpave 25.0 mixes. The details of this procedure, which is based on the macrotexture ratio determined using the "sand patch" test, are given in LS-317.

The Macrotexture Ratio, M_R, is defined by the following:

$$\text{Macrotexture Ratio, } M_R = M_s/M_c$$

Where: M_R = macrotexture ratio;
M_S = the average macrotexture depth for the segregated area under dispute; and
M_C = the control macrotexture depth for the adjacent non-segregated area

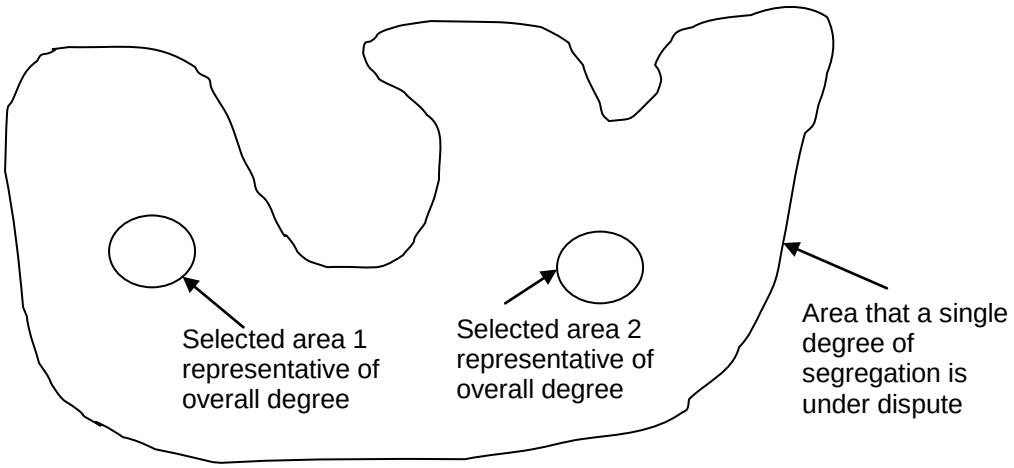
Table 4-1 (or Table 1 of LS-317 and Table 8 of F01) may be used to determine the maximum allowable macrotexture depth for a non-segregated area as well as the degree of severity of an adjacent disputed area of segregation. The results of this testing shall be binding on both the Owner and the Contractor.

Table 4-1: Allowable Macrotexture Depths and Ratios for Various Mixes

Mix Type	Maximum Allowable Macrotexture Depth of Unsegregated Area (mm)	Macrotexture Ratio, M_R		
		Degree of Segregation		
		Slight	Medium	Severe
Superpave 12.5, 12.5FC 1, 12.5FC 2	0.70	< 1.6	1.6 to 2.2	> 2.2
Superpave 19.0	0.90	< 1.8	1.8 to 2.6	> 2.6
Superpave 25.0	1.00	< 2.0	2.0 to 3.5	> 3.5

Note 4-6: LS-317 has been revised to remove the random testing location procedure and now involves the selection of two separate locations within the segregated area under dispute that are representative of the overall single degree of segregation. In order to prevent bias, one option is to have the Contractor select one location and the Owner's inspector select the other.

Figure 4-3: Challenging Severity of Segregation with LS-317



4-5 Acceptance of Geometrics and Longitudinal Joint Location (F01)

4-5.1 Pavement Width (F01)

The width of each lift placed must be measured. If the pavement width is not acceptable at any location, the pavement is rejectable and the Contractor is required to submit a written proposal for corrective action. The Contract Administrator must take random spot checks of the pavement width for each lift of HMA.

The width of each lift is acceptable when the:

a) Outside edges of the lanes and the paved shoulders are parallel to the centreline and visually uniform;
b) Width across all the adjacent lanes from the outside edge to outside edge of the paved lane surface is not less than the sum of the design lane widths; and
c) Width of the paved shoulders is not less than the designed paved shoulder width.

4-5.2 Longitudinal Joints (F01)

Longitudinal joints are acceptable if they are parallel to the lane and visually uniform when looking at the joint longitudinally (e.g. does not appear to waver as it goes down the road) and meet the requirements of the Longitudinal and Transverse Joints clause of F01. Figure 4-4 includes examples of unacceptable and acceptable longitudinal joint construction.

Figure 4-4: Unacceptable and Acceptable Longitudinal Joint Construction

UNACCEPTABLE **Acceptable**

Proper construction is an important contributor to the quality of a longitudinal joint. Poorly compacted or “starved” joints can open up or induce cracking in the pavement surface. If the Contract Administrator or his representatives suspect the joints are not being constructed

properly, (some examples of what to look for are shown in Figure 4-5), the Contract Administrator should contact the Regional Quality Assurance Section for guidance on dealing with poorly constructed joints.

Figure 4-5: Examples of Poorly Constructed Joints

4-6 Repairs (F01)

The method(s) of repair chosen by the Contractor will be subject to the approval of the Contract Administrator, after first consulting with the applicable Regional Quality Assurance Section.

Generally, repairs will either consist of removal and replacement with new HMA or a HMA overlay, where it is permitted.

For some defects, overlays on traffic lanes may be allowed on open roadways or beneath structures, if clearances between the pavement surface and the underside of the structure after overlay do not exceed the tolerable limit. Overlays on traffic lanes beneath posted structures, adjacent to curb-and-gutter or on bridge decks will not be permitted.

Repairs by removal and replacement or a HMA overlay must be full lane or shoulder width (i.e. between existing longitudinal joints) and completed using a paver.

Localized repairs may be permissible for mid-lane segregation in binder courses, where defects other than segregation are located on a paved shoulder, or where the defect is so small that it can be removed with a single core. However, it should be noted that localized repairs will not be permitted for longitudinal streaks located anywhere within the vicinity of the wheelpaths.

Where localized repairs are allowed, these repairs must:

a) Not exceed 300 mm in width;
b) Be to the full depth of the subject lift; and
c) Be entirely tack-coated.

When a defect is located on a paved shoulder, the Contract Administrator may allow an isolated repair of the paved shoulder only.

In some cases, where the defect has a maximum dimension of 150 mm, the Contract Administrator may allow it to be removed by a single core. Where removal by core is allowed, the replacement of the pavement must be consistent with the repairs required for cored holes taken for sampling purposes. The Contractor must clean out and sponge dry the cored hole.

The hole is then filled and compacted using a mechanical compactor with a round foot slightly smaller than the diameter of the cored hole. The holes are then filled to conform with the adjoining undisturbed pavement.

HMA used in all repairs must meet the requirements specified for the tender item in the Contract. All repairs must be done in a sightly and workmanlike manner complying with all requirements for placing HMA stated in the Contract. All repaired areas must be entirely tack-coated and all transverse joints in surface course repairs must butt up to the vertical face.

Surface Tolerance

Repairs for surface tolerance shall be done by either:

a) diamond grinding up to a maximum of 5 mm; or
b) removal and replacement of the full thickness of the lift.

Surface Appearance

Repairs for surface appearance (except for segregation) shall be done by either:

a) removal and replacement of the full thickness of the lift; or
b) placement of an overlay when permitted by the Contract Administrator.

Repairs for Segregation

Localized repairs are permitted for mid-lane segregation that is less than 300 m in width when it occurs in a binder course.

Repairs for Geometrics and Longitudinal Joint Location

Repairs for pavement width and/or longitudinal joint location shall be done to the full lane or shoulder width.

4-7 Payment Issues (F01)

4-7.1 Payment for Repairs (F01)

All repairs for remedial work due to segregated or otherwise visually defective mix, including pavement which has been removed and replaced, additional shouldering, traffic control, and any other work which has to be redone such as zone painting or bridge deck waterproofing will be made entirely at the Contractor's expense.

4-7.2 Price Adjustments (F01)

Some surface courses may be assessed a price reduction in lieu of repairs. For segregation, these conditions, along with the method used to calculate the price reductions are described in the Payment Adjustment for Segregated HMA clause of F01. There will no longer be a payment increase for unsegregated HMA.

Chapter Five

ACCEPTANCE OF HOT MIX ASPHALT BASED ON TEST RESULTS

5-1 General

This chapter covers the acceptance, referee process, repairs, and re-evaluation for the Hot Mix Asphalt (HMA) attributes that are based on laboratory test results for End Result Specification (ERS) acceptance. These include HMA aggregates, mix properties and compaction, lift thickness, and Performance Graded Asphalt Cement (PGAC). Acceptance of smoothness based on measurement results is included in chapter 6, acceptance of tack coat based on laboratory test results is included in chapter 8, and acceptance of bridge deck waterproofing based on measurements and laboratory test results is included in chapter 9.

For the purposes of this chapter, Ontario Provincial Standard Specifications (OPSS) and Special Provisions will be referred to as detailed in section 1-1.

5-2 Acceptance based on Laboratory Test Results

5-2.1 Acceptance of HMA Aggregates (S12)

The aggregates in each lot of 20,000 tonnes of HMA are acceptable if all the test results meet the physical and consensus property requirements listed in Tables 2 to 6 of S12.

If these requirements are not met, then the tender item price for each tonne of HMA included in that lot will receive a payment reduction of 10%, as long as the test results:

a) do not exceed more than 25% of the specified value for LS-614 or LS-606 (if accepted as an alternative);
b) do not exceed more than 10% of the specified value for LS-618;
c) do not exceed more than 15% of the specified value for LS-619; and
d) meet all the other requirements.

If the above is not met, then the lot is rejectable and all HMA within the lot of 20,000 tonnes must be removed at no cost to the Owner.

5-2.2 Acceptance of Mix Properties and Compaction (F01)

The “Combined” ERS bases the acceptance of HMA on a lot-by-lot basis. Gradation of three sieves (i.e. the “designated large sieve” (DLS), the 4.75 mm, and 75 µm sieves), Asphalt Cement (AC) content, air voids, and compaction are accepted based on the Per cent Within Limits (PWL) of the lot. An example is given in section 5-5.

For most Contracts, which use Quality Assurance (QA) test results for acceptance, the Contract Administrator will determine the acceptability of the mix based on test results generated by the

QA laboratory. For Superpave and Stone Mastic Asphalt (SMA) mixes, the QA laboratory will test one loose mix sample and one compaction core from each sublot for gradation, AC content, air voids, VMA, and percent pavement compaction.

The mean and standard deviations of the test results for each attribute measured from samples taken from each sublot are calculated according to the following formulae:

$$(1) \qquad \overline{X} = \frac{\sum x_i}{n}$$

$$(2) \qquad s = \sqrt{\frac{\sum \left(x_i - \overline{X}\right)^2}{n-1}}$$

Where: $\overline{X}$ = the lot mean, s = the sample standard deviation
x_i = the individual value or test result
n = the number of samples in the lot

The PWL for each attribute is then calculated based on the appropriate lower and upper specification limits (LL and UL, respectively) given in Table 5 (or Table 6 as appropriate) of F01 in combination with the formulae and associated Table 1 given in LS-101 (Appendix C**: LS-101**).

The payment factors for the all of the applicable attributes (gradation, AC content, air voids, VMA, and compaction) are then combined together to obtain the payment factor for "combined" mix properties and compaction (PF_{MC}) for each lot according to the method and equations outlined in the Payment Adjustment for Mix Properties and Compaction clause of F01. The final payment factor may result in an increase or decrease in payment depending on the PWL. An Excel spreadsheet entitled "ERS - Hot Mix Asphalt Pay Factor Calculation" (PH-CC-868_103F01) has been developed to assist in calculating the final payment factor for combined mix properties and compaction and is available on the Ministry's Registry, Appraisal, and Qualification System (RAQS) at www.raqs.merx.com or from the appropriate Regional QA Section (see section 3-3.1 for guidance on using this spreadsheet). An example can be found in section 5-5.

The lot is rejectable if the PWL for AC content, air voids, or compaction is < 50%.
The lot is rejectable if the PWL for the DLS, 4.75 mm, or 75 µm sieve is < 25%.
The lot is rejectable if the VMA payment factor is less than 0.500.

5-2.2.1 Additional Acceptance Requirements for SMA (F01)

The interim Air Voids Administration Procedure is no longer being used. Acceptance of air voids for SMA will now be the same as HMA (based on PWL) except with a different payment factor calculation. The lot mean VMA for SMA, must be not more than 1.0% below the design minimum for SMA.

In addition for SMA, the QA laboratory will also test one sample from each lot (e.g. the additional 3 to 5 kg sample chosen from one of the sublots) to determine its "draindown" characteristics. If a sample is found to exceed the 0.3 percent requirement for this test, then the lot shall be considered rejectable. If a lot of SMA is considered rejectable for draindown, the Regional

Quality Assurance Section should be contacted to discuss how to deal with each rejectable lot (see Note 4-2).

5-2.2.2 Acceptance of Square Metre Items (F01)

Acceptance of square metre items will based on the same QA/Referee protocols being used for all payment by tonnage Contracts. However, wherever tonnages are stated, those tonnages will be replaced with areas based on the theoretical HMA quantity in square metres from the formula provided in section 2-4.2.1.

5-2.3 Acceptance of Lift Thickness (F01)

Lift thickness is only evaluated for items measured in square metres.

Sublots shall be deemed rejected and shall be repaired when one or more of the following conditions apply:

a) lift thickness measurement is less than the minimum lift thickness specified in Table 9 of F01.
b) for successive binder lifts of the same HMA item, the combined lift thickness for these successive lifts is less than the minimum lift thickness specified in Table 9 of F01.
c) a core taken for compaction testing does not meet the minimum lift thickness specified in Table 9 of F01.

The Contract Administrator shall calculate the lot mean to one decimal point and the lot thickness payment adjustment based on all the sublot lift thickness measurements in the lot, according to LS-101.

If the lot mean is ≥ the design lift thickness, the lot shall be accepted with no thickness payment adjustment.

If the lot mean is < the design lift thickness, the payment for the mix shall be reduced by a thickness payment adjustment that shall be calculated as specified under the Payment Adjustment for Lift Thickness clause in F01.

The lot shall be rejected when the lot mean < 85% of the design thickness.

The thickness payment adjustment shall apply to each surface and binder course tender item using the horizontal area of the surface course in the lot. The formulae provided in Table 10 of F01 shall be used to calculate the Thickness Payment Adjustment. An Excel spreadsheet entitled “ERS - Thickness Payment Adjustment Calculation” (PH-CC-869) has been developed to assist in calculating the payment adjustment for lift thickness and is available on the Ministry’s Registry, Appraisal, and Qualification System (RAQS) at www.raqs.merx.com or from the appropriate Regional Quality Assurance Section (see section 3-4.1 for guidance on using this spreadsheet).

In addition, if a rejectable sublot is not to be repaired, the sublot shall be subject to the following Sublot Thickness Payment Adjustment:

$$PA_T = 0.5(\text{sublot quantity} \times \text{Contract price})$$

5-2.4 Acceptance of PGAC (1101)

A lot of PGAC is acceptable for performance grade if the test results meet the performance grading requirements (e.g. the test results meet the design high temperature (HT) grade and the design low temperature (LT) grade requirements).

A lot of PGAC that does not meet the performance grading requirements will be categorized as follows:

Minor Borderline (accepted at full payment) if:
a) test results show the LT ≤ 3°C above the design LT, and
b) test results show the HT ≤ 3°C below the design HT, and
c) [(LT - design LT) + (design HT - HT)] ≤ 3°C.

Major Borderline (accepted with a payment reduction) if:
a) test results show the LT ≤ 3°C above the design LT, and
b) test results show the HT ≤ 3°C below the design HT, and
c) [(LT - design LT) + (design HT - HT)] > 3°C but ≤ 6°C.

The payment reduction for the HMA quantity produced using major borderline PGAC = 0.05 x HMA Contract price x quantity of HMA in the lot.

Rejectable (repair or payment adjustment) if:
a) test results do not meet the requirements of either the minor or the major borderline categories above.

5-2.4.1 Additional Acceptance Requirements for PGAC (F09)

The Ministry has developed additional PGAC testing requirements for which acceptance criteria must be met when specified in a Contract with F09. These additional tests include the:
a) Ash Content (LS-227)
b) Multiple Stress Creep Recovery (MSCR) (AASHTO T 350)
c) Double-Edge-Notched Tension Test (DENT) (LS-299)
d) Extended Bending Beam Rheometer (BBR) (LS-308)

Sampling requirements for PGAC are as per Table 2 of 1101 and further described in section 2-8 **of this guide**. Table 1 of F09 specifies the acceptance criteria for the above additional tests. Lots of PGAC with test results that meet all of the acceptance criteria will be accepted at full payment. Lots with test results that do not meet the acceptance criteria in Table 1 of F09, but **also** do not **fall under** the major borderline criteria **of Table 1 of F09** can be considered minor borderline and accepted at full payment. Lots with any minor or major borderline test results are considered deficient and the Contractor shall submit a Non-Conformance Report (PH-CC-859). Major borderline **lots** will receive a payment reduction as described in section 5-2.4. When the PGAC lot is major borderline due to critical Crack Tip Opening Displacement (CTOD) a Tender Opening Date Reduction Factor (TODRF), according to Table 3 of F09, will apply. Lots with any rejectable test results shall be repaired or subject to a payment reduction.

The Contract Administrator should carefully check the Contract Documents for any additional PGAC acceptance requirements as there **will be numerous** Contracts with differing acceptance criteria **by means of a modified F09** (i.e. Extended BBR acceptance criteria will be on several Contracts, and there may be a few Contracts where PGAC is to be graded using the MSCR test).

Section 3-5 in chapter 3 provides an overview of how to fill out the PGAC Test Reporting Sheet (PH-CC-250) for these additional tests. The Contract Administrator should e-mail the PGAC test results and PGAC Test Reporting Sheet (PH-CC-250) to bituminous@ontario.ca.

5-3 Referee Testing (F01)

5-3.1 General

Depending upon the conditions described in the Contract, referee testing may be requested. If referee testing is invoked, then the referee laboratory will be selected by the Regional Quality Assurance Section and the Bituminous Section from a Roster Rotation List, which is maintained by the Owner for this purpose. This list has Regional zones, which allows local laboratories to participate in the process and reduce the transportation distance that some samples must traverse (particularly from Contracts in the Ministry's Northeastern and Northwestern Regions).

The Contract Administrator will be responsible for coordinating the delivery of the referee samples to the selected laboratory. Both parties will be permitted to observe the testing. Most referee laboratories have specific protocols for observing their testing which should be adhered to. **A referee testing request (PH-CC-883) should be completed and forwarded to** the Regional Quality Assurance Section to assign a referee laboratory as well as provide the appropriate contact information for the assigned referee laboratory.

The referee test results will be used to re-evaluate the lot and the applicable payment adjustments. Referee results will be binding on both the Contractor and the Owner and no further testing will be done except that, if repairs are carried out, the lot will be re-evaluated.

5-3.2 Contract Administrator Referee Coordination Responsibilities

Referee testing may be invoked by the Contractor provided that the associated contractual conditions have been met. The Contractor shall identify in writing the material and specific property or properties, attribute(s) and lot or sublot(s) for which the referee testing is being requested.

The Contract Administrator shall coordinate the referee request as follows:

1. Ensure the Contractor has met the timeframes to request referee as detailed in the Contract Documents.
2. Obtain a referee **testing** request form **(PH-CC-883)** from **the Ministry's Registry, Appraisal, and Qualification System (RAQS) at www.raqs.merx.com**.
3. Complete the referee request form as per the Contractor's written request and email to the appropriate Quality Assurance Officer (QAO) for the Contract. **Include all pertinent data required to complete the referee testing, e.g., Gsb, briquette mass, and recompaction temperature.** The QAO will provide the next referee laboratory and contact information from the appropriate MERO referee roster.
4. Contact the referee laboratory to inform them that they have been selected as the referee laboratory and communicate the quantity of samples and testing required verbally. If the referee laboratory cannot carry out the referee testing *in a reasonable timeframe*, inform the appropriate QAO of this issue, who will provide another referee laboratory from the referee roster.
5. Contact the Regional Quality Assurance Laboratory for this Contract and instruct them to ship the referee samples within a reasonable timeframe to the referee laboratory.
6. Once the schedule for the referee testing has been set with the referee laboratory, issue an Instruction Notice to the Contractor (cc the QAO) with the details of the referee laboratory, dates and times. The Contract Administrator shall ensure the notification is a minimum three

Business Days in advance of the date and time for referee testing. Provided that such notice is given, referee testing shall be carried out regardless of the absence of observers.

The referee laboratory will issue the resulting referee test results to the Contract Administrator, which will be used for final evaluation and payment of the material refereed. The Contract Administrator will forward the referee results and final payment adjustment to the Contractor.

The Contract Administrator will forward the referee results together with a cover letter to the applicable QAO for the Contract.

Note 5-1: This protocol should be confirmed with the QAO for amendments or additional requirements.

5-3.3 Referee for HMA Aggregates (S12)

For any HMA aggregate, the Contractor may challenge one or more attributes within five Business Days of notification that an aggregate sample does not meet the requirements.

5-3.4 Referee for Mix Properties and Compaction (F01)

Referee testing for a given lot can be invoked within five Business Days of the Contractor receiving the Contract Administrator's calculated payment factors for the lot. Referee testing may be invoked under the conditions given in and described in the Referee Testing clause of F01.

For mix properties and compaction, the Contractor may challenge one, two, or all sublots from a lot through a single request for referee testing per lot. In addition, for SMA, the Contractor can request referee testing for draindown only.

The Contractor must select referee testing for one of the following categories:

a) all mix properties only (loose mix tested for all mix properties),
b) compaction only (loose mix tested for MRD and compaction core tested for compaction),
c) all mix properties and compaction (loose mix tested for MRD and all mix properties and the compaction core tested for compaction).

When referee testing for mix properties is invoked, the referee laboratory will conduct all testing, except combined aggregate density, which the Contract Administrator shall supply.

Note 5-2: When compaction testing is invoked, the QA laboratory must send both the core and loose mix sample to the referee laboratory. The referee laboratory will determine the MRD of the loose mix sample for the sublot, and use this value in the calculation of compaction for the referee core.

5-3.5 Referee Testing for Lift Thickness (F01)

For any lift thickness measurement, the Contractor may invoke referee testing within five Business Days of receiving the measurement.

The single thickness core sample will be sent to an alternative QA laboratory than the QA laboratory that did the QA measurement. The alternative QA laboratory will re-measure the lift in question as well as all other lifts and combination of lifts.

5-3.6 Referee Testing for PGAC (1101 & F09)

The Contractor may invoke referee testing of any lot of PGAC within five Days of receiving the QA test result for the lot. Referee testing will include the actual performance grading and the additional acceptance properties and attributes specified in Table 1 of F09 **(or F09M)**.

5-3.7 Outliers in Referee Results (F01)

When an entire lot that contains three or more sublots has been referee tested, the Contractor may question an individual test result from the set of referee results only when the payment factor is less than 1.0 for the attribute in question. VMA is excluded from outlier challenges. The challenge must be made within three Business Days of the Contractor having received all of the referee test results for that lot.

When the result from one of the referee tests is challenged as an outlier, the "T" test is used to determine whether the result is either typical of or is not typical of the population. If it is not typical of the population, then it is considered an "OUTLIER". The identification of an outlier does not mean that the sampling or testing was performed incorrectly but only that it is not typical of the lot.

Outliers are identified through the principles of a normal distribution curve (i.e. values that are at the outside edges of the "bell curve" are unrepresentative of the group mean). A 10 % significance level (see Note 5 given later in this chapter) is used for the "T" test.

The precision that should be used for recording individual test results and the lot mean and standard deviation, which are used to calculate the "T"-values used in the "T" test are shown in Table 5-1.

Table 5-1: Precision to be Used When Conducting a "T" Test

Parameter	Individual Referee Test Results	Lot Mean	Lot Standard Deviation
Gradation (%)	1 decimal place	3 decimal places	4 decimal places
AC Content (%)	2 decimal places	3 decimal places	4 decimal places
Air Voids	1 decimal place	3 decimal places	4 decimal places
Pavement Compaction (%)	1 decimal place	3 decimal places	4 decimal places
Final Calculation for "T"	3 decimal places	3 decimal places	3 decimal places

Note 5-3: When conducting the "T" test, all rounding should conform to LS-100 (given in Appendix B: LS-100 Method for Rounding Off of Data and Other Numbers).

Two examples illustrating the use of the "T" Test, Table 5-2 (Critical Values for the “T” test), and the required precision (Table 5-1) are given below:

Examples from Extraction Referee Test Results

Example 1: Lot No. 4

Sublot No.	AC Content (%)
1	4.65
2	4.82
3	4.93
4	4.75
5	4.86
6	***5.18***
7	4.63
8	4.99
9	4.81
10	4.63

An inspection of the ten referee test results, shown in Example 1, might suggest that the AC content value of 5.18% for sublot 6 may not come from the same population as the AC contents determined from the samples taken from the other nine sublots. In order to test this hypothesis, it is first necessary to determine the mean $\overline{X}$, and standard deviation, s for the ten values:

$$\overline{X} = 4.825; \qquad s = 0.1758$$

In order to avoid negative numbers, the absolute value of the difference between the value being tested and the mean of all of the test values is used in equation (3) for m=6:

$$(3) \qquad T_m = \frac{\left|X_m - \overline{X}\right|}{s}$$

$$T_6 = \frac{\left|5.18 - 4.825\right|}{0.1758} = 2.019$$

From Table 5-2, for n = 10 (i.e. for ten test results), we observe that the upper 5% Significance Level is 2.176. Since 2.019 is less than or equal to 2.176, it is reasonable to conclude that the value of 5.18 is not significantly high and that there is a very good chance that it comes from the same population as the other nine values.

Table 5-2:
Critical Values for the "T" Test when the
Standard Deviation is calculated from the Same Sample

Number of Observations	10% Two-Sided Significance level (Upper or Lower 5% Significance Level)
3	1.153
4	1.463
5	1.672
6	1.822
7	1.938
8	2.032
9	2.110
10	2.176
11	2.234
12	2.285

Example 2: Lot No. 8

Sublot No.	% <4.75 mm sieve
1	51.0
2	***62.8***
3	54.6
4	52.1
5	55.8
6	53.2
7	49.7
8	50.9
9	55.6
10	53.8

An inspection of the ten referee results, shown in Example 2, suggests that the value of 62.8% for sublot 2 may not come from the same population as the other values. The mean of the ten values is $\overline{X} = 53.950$ and the standard deviation is s = 3.7263. From these values, we therefore compute T_2 for sublot 2:

$$T_2 = \frac{|62.8 - 53.950|}{3.7263} = 2.375$$

From Table 5-2 for n = 10, we observe that the lower 5% Significance Level is 2.176. Since 2.375 is greater than 2.176, it is reasonable to conclude that the value 62.8 for sublot 2 is not likely to have come from the same population as the other nine values. Further investigation of the doubtful value is therefore, warranted.

If the outlier test procedure indicates that the referee test result is not valid, then the result will be discarded, unless there is an obvious error in the calculations or in the transposing of the numbers.

When an outlier is identified in referee test results, then the sublot containing the outlier will be treated as a lot with one sublot for both mix properties and compaction. The remaining sublots will then form a separate lot.

Note 5-4: There may be cases where the precision of intermediate steps (i.e. mathematical operations on individual test results) required for final calculation of a "T" value may not be clearly stated within either the Contract or this Field Guide. As a result, the Contractor's calculations for the "T" test may be based on slightly different assumptions of precision for these intermediate steps than the calculations carried out by the Owner's representative. Where this is the case, the Contractor's calculations should be accepted, provided that he/she has used the appropriate precision and rounding procedures wherever they have been specified.

Note 5-5: The Owner's position is that outliers could occur on either side of the mean value but not on both sides simultaneously. The maximum risk of erroneously rejecting a result, which comes from the same population as the other values (i.e. the significance level), is set at 10%. This means that values on the outside 10% of the population are considered to be outliers. This significance level (two-sided) is the same as a 5% significance level on the low side and a 5% significance level on the high side.

5-3.8 Payment of Referee Testing Costs

The Contractor will have an opportunity to engage a third party referee laboratory to test the samples. The results of the referee testing will be used to determine the payment factors for the acceptance of the disputed properties for the disputed lots of HMA and will be binding on both the Owner and Contractor. The cost to do the referee testing includes the sum of the costs of each test requested and a standard shipping fee as given in Special Provision 100S61.

If an outlier is found in the referee test results, the cost of referee testing of all the sublots in the original lot shall be shared equally between the Contractor and the Owner.

Density Testing of HMA Aggregates (F01)

For the combined aggregate density, if referee testing is invoked, the cost of referee testing will be assigned as follows:

a) If the referee result is within 0.010 of the QA result, the cost of referee testing will be borne by the Contractor.
b) If the referee result is between 0.011 and 0.020 of the QA result, the cost of referee testing will be shared equally between the Contractor and Owner.
c) If the difference between the referee result and the QA result is ≥ 0.020, the cost of referee testing will be borne by the Owner.

HMA Aggregates (S12)

For physical and consensus properties of HMA aggregates, if referee testing is invoked, the cost of referee testing will be assigned as follows:

a) Referee costs will be paid by the Contractor if the referee results do not result in full payment of the lot.
b) Referee costs will be paid by the Owner in all other cases.

Mix Properties and Compaction (F01)

Mix properties and compaction referee costs will be paid by either the Contractor or Owner based on the following:

a) If the referee payment factor for compaction or mix properties is higher than the QA payment factor for compaction or mix properties by more than 0.025 and the referee results show that the lot is not rejectable, the Owner will bear the cost of the referee testing for that attribute.
b) If the referee test results show that the lot is rejectable or the referee payment factor for compaction or mix properties is not higher than the QA payment factor for compaction or mix properties by more than 0.025, the Contractor will be charged the cost of the referee testing.

Lift Thickness (F01)

For lift thickness, if referee testing is invoked, the cost of referee testing will be assigned as follows:

a) Referee costs will be paid by the Owner if the referee result is 3 mm or greater than the QA result.
b) Referee costs will be paid by the Contractor if the referee result is less than 3 mm greater than the QA result.

PGAC (1101)

For PGAC, if referee testing is invoked, the cost of referee testing will be assigned as follows:

a) Referee costs will be paid by the Owner if the referee results confirm total conformance to the Contract Documents.
b) Referee costs will be paid by the Contractor if any of the referee results do not conform to the Contract Documents.

5-4 Repairs

5-4.1 Repairs for Mix Properties and Compaction (F01)

The Contract Administrator may require that a rejectable lot be repaired or the Contractor may elect to carry out repairs in lieu of accepting a payment adjustment, if the lot is not rejectable and the total payment factor for the lot is less than 0.940.

Whenever repair work is to be carried out, the Contractor has to determine the area(s) to be repaired. However, the Owner will determine where the original sublots actually started and ended using weigh ticket information and/or diary records. The Owner should not give any advice regarding the areas to be repaired other than ensuring that all pertinent test information is available to the Contractor on request. The Contractor should be permitted to undertake additional testing at no cost to the Owner, if the Contractor wishes, in order to verify the extent of the rejectable material.

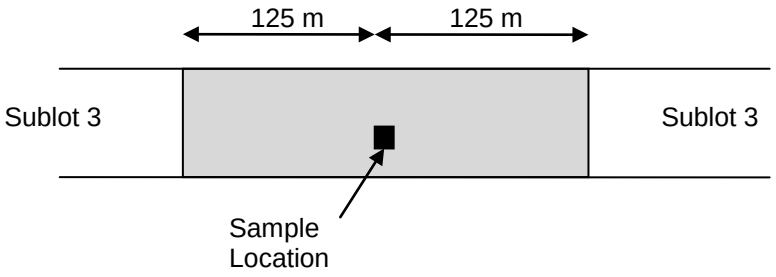
The Contractor is required to submit a list and sketches identifying the proposed locations of the repairs to the Contract Administrator, at least five Business Days prior to the intended start of the repair work in accordance with the Repairs clause of F01. Each repair area must:

1. Include at least one of the loose mix or core sample locations and the limits must be at least 125 lane-metres from the sample location, otherwise the limit will be the end of the sublot;
2. Be a minimum length of at least 250 lane-metres or, if a repair extends into another lane, no portion of a single lane repair can be less than 125 m; and

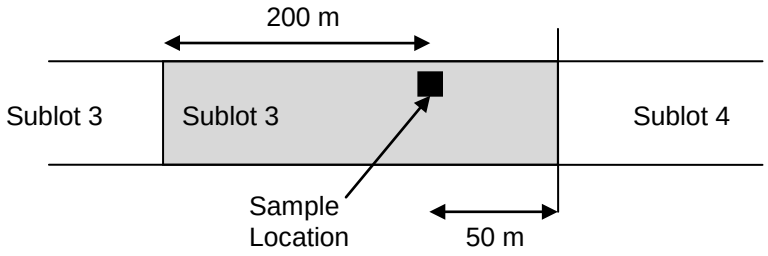
3. Be separated by at least 100 m, otherwise the separated repair areas must be combined into one continuous repair.

Some typical examples of repair areas (shown as grey plus the hatched areas, if applicable) are included below:

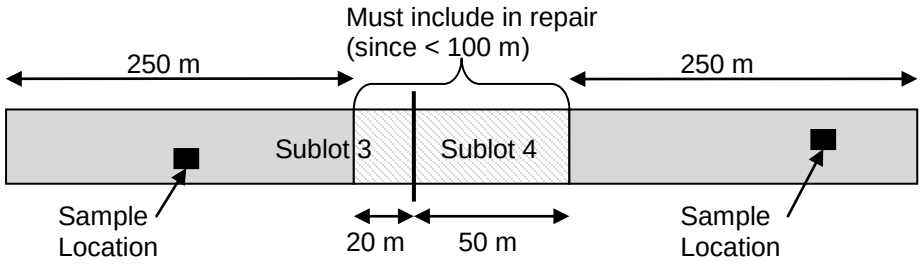
a) Typical Sublot Repair



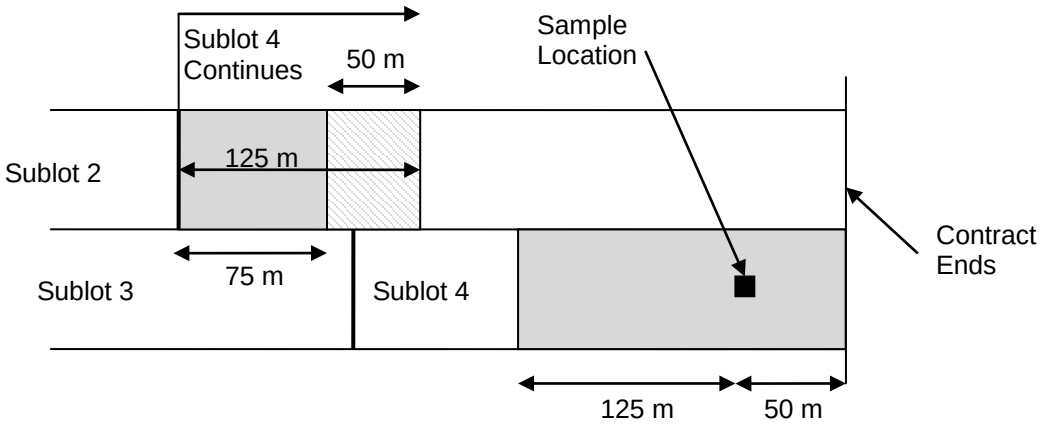
b) Sublot Repair Near End of Sublot



c) Repairs in Two Adjacent Sublots that are Separated by less than 100 m



d) Repairs Which Extend into an Adjacent Lane



Both ends of each repair area that are selected by the Contractor must be extended by one metre and a slab sample or clusters of cores must be taken from these extended areas to provide sufficient material for testing that is required for gradation, AC content, and air voids and/or compaction, unless the limit coincides with the beginning of a sublot that is being left unrepaired. The test results for these samples will be used to determine if the mix within those extended ends is within the specified limits given in Table 5 of F01. If the HMA still turns out to be rejectable, then the Contractor will be required to extend the repair area by a minimum of 25 m (plus the additional metre at each end) before re-sampling and re-testing begins again.

Once the repairs have been made to all or part(s) of a lot, two separate lots will be re-evaluated.

One lot will include the unrepaired sublots plus the unrepaired portions of the repaired sublots. That lot will be assessed on the basis of the loose mix or core samples or both the loose mix and core samples representing the unrepaired sublots. However, if there are only one or two sublots in a lot that are not repaired, then the Contract Administrator will include those sublots as part of the previous or next lot. If the referee laboratory has tested the lot, then the referee test results will be used to determine the payment factors instead of the original test results.

The second lot will normally consist of the HMA used for the repair itself, unless the Contract Administrator and the Contractor have agreed to include it as part of the current lot being produced. The repaired areas will be tested for all criteria.

5-4.2 Repairs for Lift Thickness (F01)

No repairs are allowed for excess lift thickness and when a repair for lift thickness is required, the entire length of the sublot must be repaired.

5-5 Example Calculations for PWL and Combined Payment Factors (F01)

This section presents an example of how to calculate a payment factor based on PWL calculations using LS-101 and compaction data from the following example for Superpave 12.5. This example, entitled, “ERS 2015 - Hot Mix Asphalt Pay Factor Calculation” was determined from the EXCEL® computer program described in chapter 3.

ERS 2016 - Hot Mix Asphalt Pay Factor Calculation

FINAL COMPOSITE LOT PAY FACTOR CALCULATION

February 2016 Version

CONTRACT	2015-XXXX	Lot No.	4
HIGHWAY	X	Lot Size (m^2)	4000
REGION	N-Eastern	No. Sublots	10
MIX TYPE	SUP125	Date Paved	05-Jul-16
MIX DESIGNATION	Warm Mix	Tested (QA)	05-Jul-16
ITEM No.	3		

Course: Surface

PLEASE CHECK REFEREE SHEET TO ENSURE THAT NO UNNECESSARY DATA IS INCLUDED

Sublot Data Input

JMF Id.	DLS	4.75 mm	75 µm	AC Content	Air Voids	Compaction	VMA
2015-XXX-XXX	73.5	51.8	3.8	4.6			14.0
Sublot 1	78.9	54.5	3.9	4.4	4.2	94.6	15.1
Sublot 2	76.3	55.9	4.1	4.3	4.0	92.8	14.8
Sublot 3	76.3	54.1	1.9	4.4	4.0	93.0	14.6
Sublot 4	69.9	45.3	3.7	4.2	4.3	93.5	14.9
Sublot 5	77.7	54.7	4.2	4.4	3.8	92.3	14.8
Sublot 6	73.1	50.7	4.1	4.3	3.8	92.8	13.9
Sublot 7	78.7	55.1	2.8	4.8	3.7	92.3	13.9
Sublot 8	78.0	57.3	4.4	4.4	2.8	92.6	14.5
Sublot 9	76.1	54.8	4.4	4.4	3.7	92.5	14.7
Sublot 10	68.8	46.9	3.1	4.1	4.6	94.5	14.2
Sublot 11							
Sublot 12							

Lot Calculation Results

COUNT	10	10	10	10	10	10	10
Lot Mean	75.4	52.9	3.7	4.4	3.9	93.1	14.5
Std Dev	3.60	3.98	0.82	0.19	0.48	0.85	0.41
LL	68.5	46.8	1.8	4.2	2.5	91.5	
UL	78.5	56.8	5.8	5.1	5.5	97.0	
QL	1.92	1.53	2.32	1.05	2.92	1.88	
QU	0.86	0.98	2.56	3.68	3.33	4.59	
PL	99	95	100	86	100	99	
PU	81	84	100	100	100	100	
PWL	80	79	100	86	100	99	
PF	0.9860	0.9830	1.0034	1.000	1.020	1.024	1.000

Calculation of Total Pay Factor

$PF_{G(SUB)}$ =	2.9724
PF_G =	0.9908
$PF_{GAC(SUB)}$ =	1.9908
PF_{GAC} =	0.9954
PF_{VOIDS} =	1.0200

$PF_{M(SUB)}$ =	2.0154
PF_M =	1.0154
$PF_{MC(SUB)}$ =	2.0394
PF_{MC} =	**1.0394**

Ministry Rep. Signature _____ Contractor Rep. Signature _____

Date: _____ Date: _____

Comments: _____

Copy to: Regional Quality Assurance Contract Administrator Contractor Originator

PH-CC-868_103F01_FEB16_Example

1) Percent Within Limits Calculation

Compaction Data for Superpave 12.5 Mix

94.6	92.8	93.0	93.5	92.3
92.8	92.3	92.6	92.5	94.5

(i) Calculate the Mean ($\overline{X}$) of the above data to one decimal place; and the Standard Deviation (s) of the above data to two decimal places; using equations (1) and (2), respectively:

(1) $$\overline{X} = \frac{\sum x_i}{n}$$

(2) $$s = \sqrt{\frac{\sum \left(x_i - \overline{X}\right)^2}{n-1}}$$

Where: X_i = the individual compaction value
and n = the number of samples in the lot

$$\text{Mean, } \overline{X} = \frac{94.6 + 92.8 + ... + 94.5}{10}$$

= 93.1

$$\text{Standard Deviation, } s = \sqrt{\frac{(94.6 - 93.1)^2 + (92.8 - 93.1)^2 + ... + (94.5 - 93.1)^2}{9}}$$

= 0.85

(ii) Calculate the Quality Indices, Q_L and Q_U to two decimal places, from the equations given in section 5.1 of Appendix C: LS-101 using the Lower Quality Limit (LL) and Upper Quality Limit (UL) From Table 5 (for pavement compaction) of F01:

$$Q_L = \frac{\overline{X} - LL}{s}$$

$$= \frac{93.1 - 91.5}{0.85} = 1.88$$

$$Q_U = \frac{UL - \overline{X}}{s}$$

$$= \frac{97.0 - 93.1}{0.85} = 4.59$$

Where: Q_L = Lower Quality Index Q_U = Upper Quality Index
LL = Lower Limit UL = Upper Limit

(iii) From Table 1, given at the end of Appendix C: LS-101 Method for Calculation of Percent Within Limits, first determine P_L and P_U for n=10 and then select the next highest values:

P_L = 99 From Q_L = 1.88

$P_{U=}$ 100 From Q_U = 4.59

(iv) From the Equation given in section 5.2 of Appendix C: LS-101 determine the PWL:

$$PWL = (P_L + P_U) - 100$$

= (99+100) - 100

= 99

(v) From Table 7 at the end of F01, the Payment Factor for compaction is determined to be 1.024.

2) Determining Combined Payment Factor

Payment factors for Superpave 12.5 Mix (From the Same Example)

PF_{DLS}	=	Payment Factor for Designated Large Sieve	=	0.9860
$PF_{4.75}$	=	Payment Factor for the 4.75 mm sieve	=	0.9830
PF_{75}	=	Payment Factor for the 75 µm sieve	=	1.0034
PF_{AC}	=	Payment Factor for Asphalt Cement	=	1.0000
PF_{AV}	=	Payment Factor for Air Voids	=	1.0200
PF_{C}	=	Payment Factor for Compaction	=	1.0240
PF_{VMA}	=	Payment Factor for Voids in the Mineral Aggregate	=	1.0000

a) Gradation

For Superpave 37.5, Superpave 25.0, Superpave 19.0, Superpave 12.5, Superpave 12.5FC 1, Superpave 12.5FC 2, SMA 19.0 and SMA 12.5, from Formula (2) in the Payment Factor for Gradation clause of F01, Calculate $PF_{G(SUB)}$:

(2) $PF_{G(SUB)} = PF_{DLS} + PF_{4.75} + PF_{75}$

Since the mix involved is a Superpave 12.5, $PF_{G(SUB)}$ is as follows:

$PF_{G(SUB)}$ = 0.9860 + 0.9830 + 1.0034

= 2.9724

Calculate PF_G from Formulae (3) or (4) in F01:

(3) If $PF_{G(SUB)}$ is greater than or equal to 3, then $PF_G = PF_{G(SUB)} - 2$

(4) If $PF_{G(SUB)}$ is less than 3, then $PF_G = PF_{G(SUB)}/3$

Since $PF_{G(SUB)}$ is less than 3:

$PF_G = 2.9724/3$

$= 0.9908$

For Superpave 9.5, Superpave 4.75 and SMA 9.5, from Formula (5) in the Payment Factor for Gradation clause of F01, Calculate $PF_{G(SUB)}$:

(5) $PF_{G(SUB)} = PF_{4.75} + PF_{75}$

Calculate PF_G from Formulae (6) or (7) in F01:

(6) If $PF_{G(SUB)}$ is greater than or equal to 2, then $PF_G = PF_{G(SUB)} - 1$

(7) If $PF_{G(SUB)}$ is less than 2, then $PF_G = PF_{G(SUB)}/2$

Since the mix involved is Superpave 12.5, do not use Formula (5), (6) or (7).

b) Combined Gradation and Asphalt Cement Content

From Formula (8) in F01, Calculate $PF_{GAC(SUB)}$:

(8) $PF_{GAC(SUB)} = PF_G + PF_{AC}$

$= 0.9908 + 1.0000 = 1.9908$

Calculate PF_{GAC} from Formulae (9) or (10) in F01:

(9) If $PF_{GAC(SUB)}$ is greater than or equal to 2, then $PF_{GAC} = PF_{GAC(SUB)} - 1$

(10) Since $PF_{GAC(SUB)}$ is less than 2, then $PF_{GAC} = PF_{GAC(SUB)}/2$

$PF_{GAC} = 1.9908/2$

$= 0.9954$

c) Payment Factor for Voids

For Superpave mixes:

Since lot mean VMA is less than or equal to 0.5% below minimum VMA, then:

$$PF_{VMA} = 1.000$$

Otherwise use Formulae (11) or (12) in F01 i.e.:

(11) If $(VMA_{min} – VMA_{mean}) \geq 2.5$, then $PF_{VMA} = 0$

(12) If $(VMA_{min} – VMA_{mean}) < 2.5$, then:

$$PF_{VMA} = 0.8000\text{-}0.4(VMA_{min} – 0.5 - VMA_{mean})$$

For SMA mixes:

If lot mean VMA is less than or equal to 1.0% below minimum VMA, then:

$$PF_{VMA} = 1.000$$

Otherwise use Formulae (13) or (14) in F01 i.e.:

(13) If $(VMA_{min} – VMA_{mean}) \geq 3.0$, then $PF_{VMA} = 0$

(14) If $(VMA_{min} – VMA_{mean}) < 3.0$, then:

$$PF_{VMA} = 0.8000\text{-}0.4(VMA_{min} – 1.0 - VMA_{mean})$$

d) Comparing the Payment Factors of Air Voids and VMA

Since PF_{VMA} is equal to 1.000:

$$PF_{VOIDS} = PF_{AV} = 1.0200$$

However, if PF_{VMA} is less than 1.000, PF_{VOIDS} is the lesser of PF_{AV} and PF_{VMA}

e) Combined Mix Properties

From Formula (15) in F01, Calculate $PF_{M(SUB)}$:

(15) $PF_{M(SUB)} = PF_{GAC} + PF_{VOIDS}$

$= 0.9954 + 1.0200$

$= 2.0154$

Calculate PF_M from Formulae (16) or (17) in F01:

(16) If $PF_{M(SUB)}$ is greater than or equal to 2, then:

$PF_M = PF_{M(SUB)} - 1$

$= 2.0154 - 1$

$= 1.0154$

(17) However, if $PF_{M(SUB)}$ is less than 2, then:

$PF_M = PF_{M(SUB)}/2$

f) Combined Mix Properties and Compaction

Calculate $PF_{MC(SUB)}$ Using Formula (18) in F01:

(18) $PF_{MC(SUB)} = PF_C + PF_M$

$= 1.0240 + 1.0154$

$= 2.0394$

Calculate PF_{MC} from Formulae (19) or (20) in F01:

(19) Since $PF_{MC(SUB)}$ is greater than or equal to 2 then:

$PF_{MC} = PF_{MC(SUB)} – 1$

$= 2.0394 – 1.0000$

$= 1.0394$

(20) However, if $PF_{MC(SUB)}$ is less than 2 then:

$PF_{MC} = PF_{MC(SUB)}/2$

PF_{MC} has to be reported to four decimal places in accordance with LS-100 (Appendix B: LS-100 Method for Rounding Off of Data and Other Numbers).

5-6 Payment Adjustment for AC Content and Changes in the AC Price Index (F01)

The Ministry has implemented a payment adjustment to compensate the Contractor, or allow for a rebate to the Owner, for the difference in the AC content used for bidding purposes and that required for the Job Mix Formula (JMF) as shown in section 5-6.2 and the Payment Adjustment for Asphalt Cement Content clause of F01. In addition, there is also a payment adjustment to account for changes in the price of AC throughout the Contract as shown in section 5-6.3 and the Payment Adjustment for Changes in the Asphalt Cement Price Index clause of F01.

5-6.1 HMA Quantity Calculation (F01)

The quantity of HMA for use in the payment adjustment calculations is the tonnage of HMA accepted into the work.

When the unit of measurement is “square metres”, the quantity of HMA is determined using the theoretical tonnage. The theoretical tonnage is calculated by the Contract Administrator using the formula shown in the Hot Mix Asphalt Quantity Calculation clause of F01.

5-6.2 Payment Adjustment for AC Content (F01)

For progress payment purposes, payment adjustments will be made on the monthly progress payment certificate for the months in which HMA paving occurs.

The payment adjustment for AC content, PA_{AC} is calculated using the formula shown in the Payment Adjustment for Asphalt Cement Content clause of F01.

5-6.3 Payment Adjustment for Changes in the AC Price Index (F01)

A payment adjustment will be applied based on changes to the Ministry's performance graded AC price index unless the Contractor opts out. The price index is available on the Ministry’s Registry, Appraisal, and Qualification System (RAQS) at www.raqs.merx.com and is published monthly in the Contract Bulletin section.

A payment adjustment per tonne of new AC will be established for each month in which paving occurs when the price index for the month differs by more than 5% from the price index for the month prior to Tender Opening. When the price index differential is less than 5%, there will be no payment adjustment established for that month. The payment adjustment for the month will be calculated from Table 12 of F01.

The payment adjustment per tonne will apply to the quantity of new AC in the HMA accepted into the work during the month for which it is established. The quantity of new AC includes all grades of AC supplied by the Contractor with and without polymer modifiers.

For mixes which contain RAP, or RST or both, the percentage of new AC will be determined from the difference between the AC content required by the JMF and the AC content of the RAP, or the RST, or both incorporated into the HMA, as calculated by the Contract Administrator (see section 1-2.1.1).

For mixes containing a liquid anti-stripping additive, the percentage of anti-stripping additive will be deducted from the percentage of new AC. No other deductions will be made for any other additives.

5-7 Payment Adjustment for HMA Aggregate Density (F01)

A payment adjustment for aggregate density will apply only for Superpave 12.5FC 1, Superpave 12.5FC 2, SMA 19.0, SMA 12.5, and SMA 9.5 items measured in tonnes. The payment adjustment will be calculated for each lot according to Formulae 21 and 22 in the Payment Adjustment for Aggregate Density clause of F01.

5-8 Payment for HMA Miscellaneous Items (F01)

The HMA miscellaneous item does not cover the HMA used to complete the work, it only includes the labour, Equipment, and other Materials required to do the work. Payment for the HMA used in miscellaneous areas will be paid under the corresponding HMA item of the same mix type.

Chapter Six

ACCEPTANCE OF HOT MIX ASPHALT BASED ON SMOOTHNESS

6-1 General (F31)

The purpose of this section is to provide guidelines for the acceptance of asphaltic pavement based on surface smoothness measurements taken by a high-speed laser inertial profiler when Special Provision 103F31 is included in the Contract Documents. For the purposes of this chapter, Ontario Provincial Standard Specifications (OPSS) and Special Provisions will be referred to as detailed in section 1-1.

Since every inertial profiler uses its own manufacturer's software and methods of data filtering to determine International Roughness Index (IRI), the raw data files from all inertial profilers will be run through a common software program called ProVAL which has been developed by the Transtec Group in the U.S. and can be downloaded free of charge from the following website: www.roadprofile.com

Appendix D: ProVAL includes a user guide for ProVAL version**s** 3.4 **and 3.5**, developed by the Bituminous Section that provides a step-by-step guide to process profiler data files.

Where F31 is included, all surface courses will be measured for smoothness by an independent Consultant using a high speed inertial profiler, except for the exempt areas outlined in the Surface Smoothness Measurement clause of F31. **Alternatively, the Consultant may measure the entire Contract and then exclude the exempt areas during office analysis.**

All of the QA and referee *inertial profilers are now equipped with a GPS-DMI* ***(Global Positioning System-Distance Measuring Device)*** *system that precludes the use of the reflectors.* ***F31 and LS-296 have been revised to allow the use of this system. In particular,*** *the Ministry* ***urges*** *the use of this* ***system*** *on freeways and multi-lane highways with high traffic volumes. The profiler operator* ***has the option of using either*** *GPS-DMI* ***or reflector cones****.*

6-2 Surface Tolerance (F01)

The requirements for surface tolerance using a straight edge, which are included in the Surface Tolerance clause of F01, apply to all Hot Mix Asphalt (HMA), regardless of whether or not surface smoothness measurements using a profile-measuring device also apply (see Note 6-1).

Tolerance measurements should be carried out by the Contractor for quality control. In addition, at any time, the Contract Administrator may require that the Contractor take additional tolerance measurements at his (or her) direction. In some instances, the Owner's representatives may take the measurements as well (see Note 6-1).

Note 6-1: Where sublots have been measured by an inertial profiler, tolerance measurements using a 3 m straight edge can be used to check longitudinal joints and the

transverse profile across a lane. The straight edge may also be used to confirm the locations of transverse bumps (localized roughness), but it should not be used to replace inertial profiler results. Since the baseline of an inertial profiler is not the same as a 3 m straight edge, different results should be expected.

6-3 Correlation, Calibration, Approval, and Hiring of Profiler Operators (F31)

6-3.1 Correlation and Calibration (F31)

The Owner will provide an inertial profiler meeting the requirements given in LS-296 for all surface smoothness measurements. All such devices must be approved by the Ministry through participation in a correlation program, which will be carried out once per year at a site that has been designated for this purpose. Every successful profiler will receive a certificate from the Bituminous Section indicating that the profiler has passed the correlation program in a given year. The certificate also bears the names of the operators that participated in the correlation program. The Contract Administrator may ask the profiler operator to provide a copy of the latest certificate.

For the purposes of this Field Guide, the inertial profiler that will be used for acceptance will be referred to as the "Owner's Profiler", regardless of who actually owns and/or operates it.

Both the height calibration and the so-called "bounce" tests (to check the operation of the accelerometer) will be performed on a daily basis. The distance calibration will be checked, at least once a week or at the request of the Contract Administrator. All such calibrations will be carried out in accordance with LS-296. The Contractor will be allowed to observe the daily calibration checks.

6-3.2 Approval of Profiler Operators (F31)

Every inertial profiler that will be used on Ministry Contracts must be operated by a person approved by the Ministry. Each profiler operator will be required to provide a written statement to the Ministry by the manufacturer of the inertial profiler that he/she has been adequately trained in the operation of his or her inertial profiler.

In addition, each profiler operator will be required to participate in the annual correlation program and demonstrate his/her ability to operate their inertial profiler and calculate IRI and localized roughness using the ProVAL software to the satisfaction of the Owner. The list of qualified operators is posted on the Ministry's Registry, Appraisal, and Qualification System (RAQS) at www.raqs.merx.com under Service Provider / RAQS Legacy System / Contractor / Qualified Laboratories / Bituminous.

6-3.3 Hiring of Inertial Profiler for Acceptance Testing (F31)

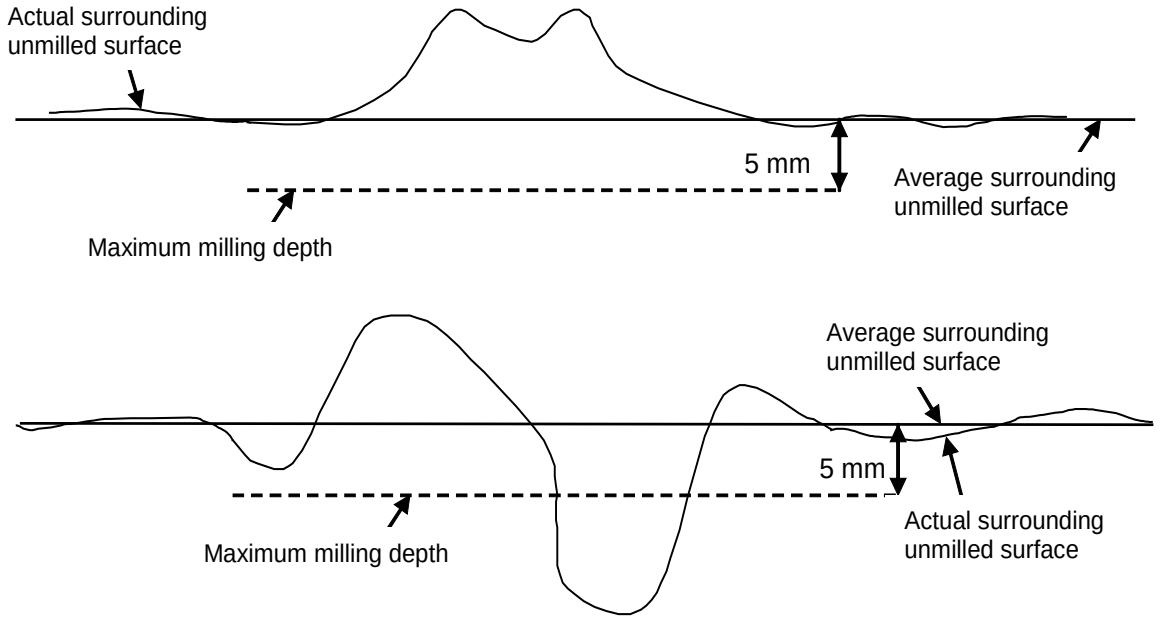
Depending on the Region, either the Contract Administrator or the Regional Quality Assurance Section will be responsible for hiring an inertial profiler to do the QA acceptance testing. Such testing begin**s when** the Contractor has clearly marked out the sublots and removed any debris from the pavement to the satisfaction of the Contract Administrator.

6-4 Smoothness Correction of Pavement beneath Surface Courses (F01)

Unless otherwise specified in the Contract Documents, the Contractor may place HMA padding on any pavement underlying a surface course in order to meet the surface smoothness requirements as per the Correction of Pavement beneath Surface Courses clause of F01. This padding shall be a mix type acceptable to the Owner.

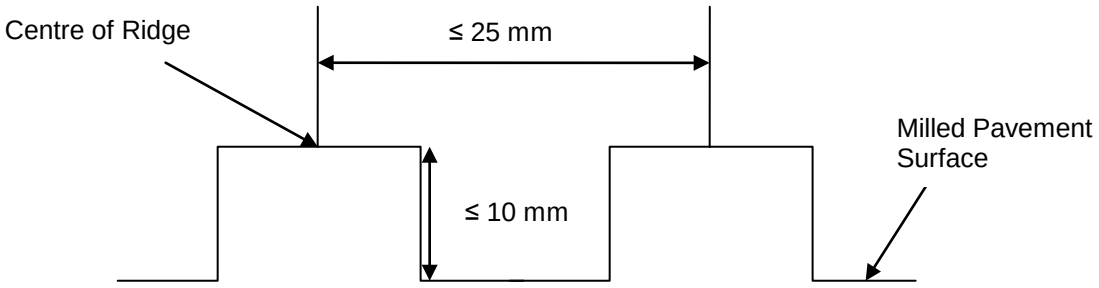
Grinding or milling will also be allowed for such corrections of any pavement underlying a surface course, but only if the thickness of those pavements after grinding or milling is not reduced by more than 5 mm below the general profile of the surrounding unground or unmilled pavement surface (see Figure 6-1).

Figure 6-1: Diamond Grinding or Micromilling Limits



An acceptable milled surface shall not be more than 25 mm from ridge to ridge, and the ridge to valley depth shall not be more than 10 mm. See Figure 6-2 for the dimensions of an acceptable milled surface.

Figure 6-2: Acceptable Milled Surface



6-5 Measurement Frequency (F31)

6-5.1 Lot and Sublot Size (F31)

For surface smoothness measurements, a lot is defined as all pavement in a given surface course Contract item that has been measured by the Owner's profiler. Each lot will generally be divided into 100 m single lane sublots, upon which corrective work and individual pay adjustments for surface smoothness will be evaluated.

At the pre-pave meeting, the Contract Administrator will present a draft sketch of the proposed locations for each sublot to the Contractor, in accordance with the guidelines presented in this chapter. The sketch should show each lane with all of its sublots, any areas that will be excluded from being measured by the Owner's profiler, and any other areas that are to be measured for information purposes (i.e. will not have surface smoothness-related payment reductions or repairs). It is not required that the sketch be drawn to scale. The stations covered by each sublot should be readily apparent from the sketch.

Each sublot will be assumed to be 100 m long, unless it is otherwise indicated on the sketch. In order to maintain 100 m sublots on steep grades or superelevations with even stations, the stations of the sublots may have to be slightly adjusted, in order to compensate for the actual measurements taken along the profile (see Note 6-2). Slightly shorter or longer sublots may be designed at the end of the steep grade or superelevation, in order to go back to even stations for any sublots that follow.

It is recommended that, for each traffic lane, all included sublots should be numbered sequentially in the direction of traffic, *no sublot should have the same sublot number as any other one* (unless one of them is from a pavement surface beneath the other) and no sublot should be carried over from one lane to the next. If only one direction is involved, then the numbering should be in the chainage direction, if at all possible. A sublot should not be broken by any area that will not be measured.

The Contractor will be given the opportunity to comment on the sketch and propose changes to it prior to the start of paving of the surface course. The Contract Administrator will evaluate the validity of all of the areas, which the Contractor has proposed not to be measured. The Contract Administrator will have the final decision regarding the sublots that will be measured for payment and the Contract Administrator must finalize the sketch before paving of the surface course begins. The Surface Smoothness Measurement clause of F31 identifies areas that can be excluded from smoothness testing. **No changes to the sublot sketch shall be allowed after the paving of the surface course mix has started.**

The Contract Administrator should mark an "X" through each accepted sublot on his or her copy of the sketch, to show that it has been completed and accepted.

Note 6-2: It should be noted that, on grades, if the surveyed stations are horizontally projected they will not match the actual distances travelled along the profile. Such differences should be taken into account by the Contract Administrator when drawing the sketch, since all sublots must be 100 m along the actual measured profile (except at the end of a lane etc.). The Owner's profiler must not deviate from the stated stations by more than 1%. To avoid this, the profiler operator should be aware that LS-296 requires that no individual profile run can be more than 2,000 m in length. Therefore, when each profile run has been completed, the profiler operator should set up at the beginning of the first sublot following the last one that was completed.

6-5.1.1 Additional Excluded Areas (F31)

At the pre-pave meeting, the Contract Administrator will discuss the sketch with the Contractor. At that time, the Contractor may propose any additional areas shown on the sketch, that the Contractor believes should be excluded from smoothness measurement. Such areas may include certain intersections where the Contractor feels that the truck traffic cannot be sufficiently controlled before the HMA has sufficiently cooled or any other areas where the Contractor expresses concern that circumstances beyond his or her control may prevent him/her from obtaining acceptable smoothness. The Contract Administrator will evaluate the Contractor's concerns and, after discussing with the appropriate Regional Quality Assurance Section, the Contract Administrator may or may not decide to modify the sketch. **The sublot sketch shall be finalized prior to the start of paving.**

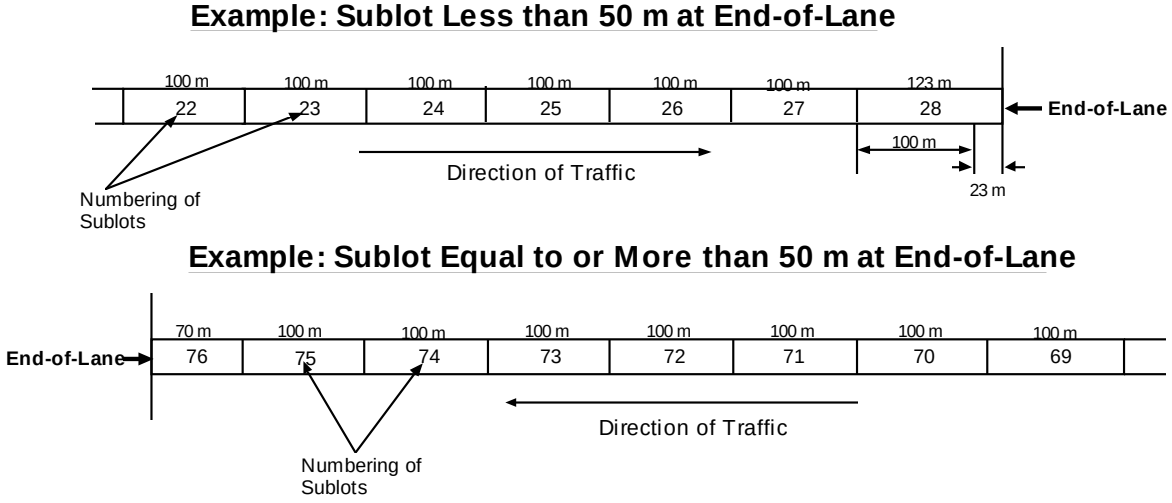
The Contractor should be aware that no other areas may be excluded from the requirements for surface smoothness measurements (unless damage occurs due to circumstances beyond the Contractor's control) once paving of the surface course begins.

6-5.1.2 Sublots at End-of-Lane (F31)

If the portion left at the end of the lane is less than 50 m in length, then it will be added to the previous sublot in the lane.

If, after the last complete sublot within a lane, the remaining portion of the lane is greater than or equal to 50 m in length, then that remaining portion of the lane will be considered to be the last sublot in the lane.

Figure 6-3: End-of-Lane Sublots

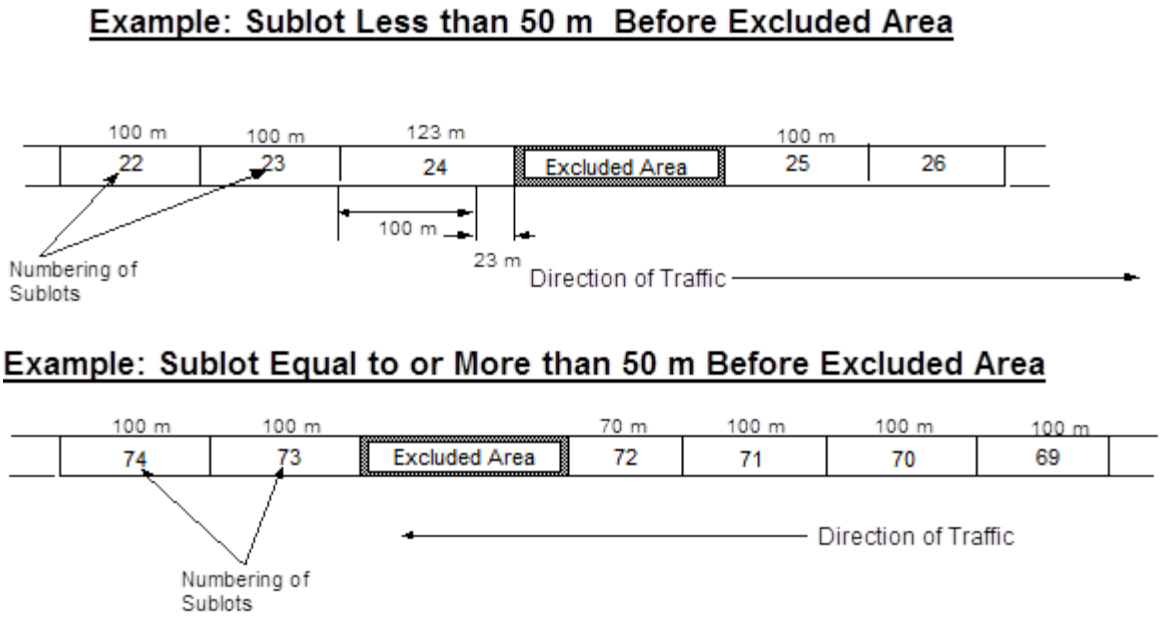


6-5.1.3 Sublots before Excluded Areas (F31)

If an area is encountered that is excluded from smoothness measurements, then the portion of the lane encountered prior to that area may either be added to the previous sublot or a new sublot created in the same manner as described for end-of-lane sublots in section 6-5.1.2.

The sequential numbering of the sublots should resume after the excluded areas.

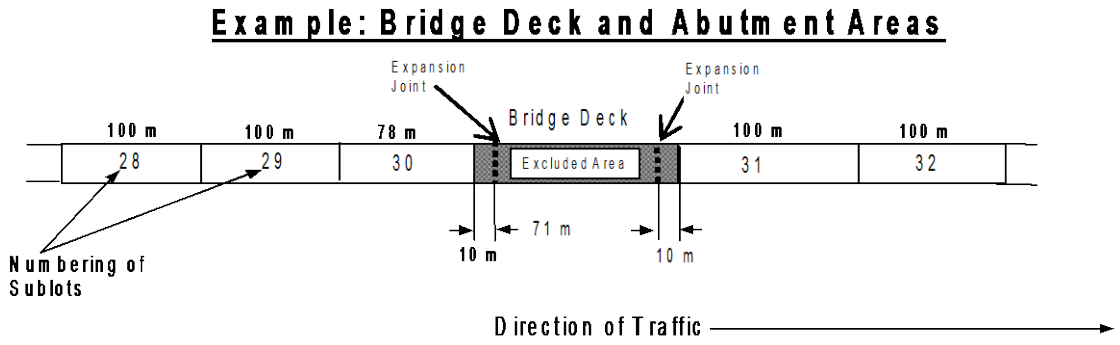
Figure 6-4: Sublots before Excluded Areas



6-5.1.4 Bridge Decks (F31)

The example in Figure 6-5 shows a bridge deck located between two expansion joints. Bridge decks and within 10 m of expansion joints are excluded from measurements.

Figure 6-5: Bridge Decks



6-5.2 Measurement of Surface Smoothness (F31)

Any alteration of the surface course after paving and prior to the initial smoothness measurements, by micro-milling, diamond grinding, or any other method, shall not be permitted.

The Contractor must clearly mark out each sublot on the pavement surface or the shoulder, prior to testing. All such marks (or stakes) must remain visible and intact until all smoothness measurements are completed and accepted. **When reflectors are used for QA or referee measurements,** the Contractor is responsible for obtaining from the profiler operator the reflectors, used to automatically turn on/off the Owner's profiler, and place them on the left/right shoulder or the highway median at the beginning and end of each profile run as identified by the profiler operator. After smoothness measurements are completed each day, the Contractor shall remove the reflectors and return them to the profiler operator.

When GPS-DMI technology is used for QA or referee measurements, the profiler operator will need to collect static GPS coordinates while stopping on the shoulder. The Contractor shall be responsible to provide the necessary traffic protection to the profiler for collection of the static GPS coordinates.

The Contractor will provide written confirmation to the Contract Administrator when 50% and 100% of the surface course has been completed and, for carry-overs, when all surface courses have been completed within a given calendar year. The Owner's profiler will begin surface smoothness testing **after** receiving each of these written confirmations by the Contractor, as long as the Contractor has marked out the sublots and has cleared the surface to be tested of any loose stones, debris etc., to the satisfaction of the Contract Administrator.

All measurements that are taken by an inertial profiler will be conducted in accordance with LS-296. The individual payment adjustment for a sublot will generally be based on the first three runs of the Owner's profiler, unless technical problems have forced the profiler operator to abandon and replace one or more runs.

The profiler operator will calculate IRI and all incidents of localized roughness in both wheelpaths from all runs of each sublot and provide summaries in the Smoothness Acceptance and Price Adjustment spreadsheet (PH-CC-874) on CD's, DVD's, or USB's to the Contract Administrator, who will in turn provide them to the Contractor after the measurements are completed along with the information required in the Inertial Profiler Measurements clause of F31. The Contract Administrator is responsible for calculating the final pay factors (based on IRI) and payment reductions (based on localized roughness) according to the Payment Adjustment for Surface Smoothness **subsection** of F31. The Contract Administrator should also e-mail the smoothness data to bituminous@ontario.ca.

6-5.2.1 Damage beyond the Contractor's Control (F31)

The Contractor will also be expected to make a reasonable effort to prevent vehicles at intersections, private entrances, and exits from crossing newly placed HMA before it has been sufficiently compacted and allowed to cool. However, if any area has still been damaged, due to circumstances beyond the Contractor's control prior to being measured for payment purposes, then the Contractor must inform the Contract Administrator, in writing, within one Business Day of the damage occurring.

If such damage has occurred to the existing surface after milling and/or padding, then the Contractor must not cover the affected area until the Contract Administrator has made a decision.

The Contract Administrator will evaluate the Contractor's submission and decide if the Contractor could not have foreseen such damage, prior to construction. The Contract Administrator will then decide if such an area should be excluded in the final calculation for the payment factor and that decision will be binding on both the Owner and the Contractor.

6-5.3 Referee Testing (F31)

The Contractor may make a single written request for "Referee Testing" after each milestone and may request referee testing only once for any particular sublot within five Business Days after receiving all the summary sheets and files. The request must **identify** the sublot**s** that **are** to be re-measured. The referee profiler will be retained by the Regional Quality Assurance Section from a Roster Rotation List maintained by the Bituminous Section. The conditions surrounding the referee testing, how the results are evaluated and the consequences of differences between the referee results and the Quality Assurance (QA) results are given in F31. All sublots that are requested for referee testing will be re-measured three times using a "referee inertial profiler", within 15 Business Days of the Contract Administrator receiving the Contractor's written request for referee testing. In the event the weather conditions do not allow for reliable results within the 15 Business Day window, the Contract Administrator shall notify the Contractor of such a situation and make arrangements with the profiler operator so that the measurements are conducted as soon as favourable ambient conditions arise. The disposition of all of the re-measured sublots and all incident(s) of localized roughness that are located within those sublots shall be based on the referee measurements and the results shall be binding on both the Contractor and the Owner.

6-6 Repairs and Redecisioning (F31)

At least five Business Days before any repairs are carried out, the Contractor will be required to submit a proposal, which must be agreed to by the Contract Administrator (see Note 6-3). The repair options that are available, the extent of repairs, and the conditions surrounding redecisioning are given in F31.

If the Contractor has proposed diamond grinding as one of the repair options but the Contractor wishes to grind down more than 5 mm below the general profile of the surrounding pavement surface (see Figure 6-1), then he/she may be required to prove by coring that the design thickness of the surface course will not be reduced by more than 5 mm after the repair. In addition, the slurry created by the diamond grinder must be completely removed from the site (i.e. it cannot be simply pumped onto the shoulder or over the shoulder into a drainage ditch) and must be disposed of in accordance with all applicable regulations.

After repairs are made to all or part of a sublot, the entire sublot shall be re-measured by the Owner's profiler at the Contractor's cost and re-evaluated for incidents of localized roughness and IRI.

Note 6-3: It should be noted that some Contractors may propose to use steel drum rollers after the pavement has cooled to improve smoothness. Cold rolling or any other compaction method, which has the potential to cause checking, will never be considered an acceptable method of repair and should not be accepted by the Contract Administrator.

6-7 Payment Issues (F31)

Price adjustments are determined based on IRI and localized roughness. The IRI calculations and the locations and magnitudes of the localized roughness will be determined by the profiler

operator using ProVAL and the Smoothness Acceptance and Price Adjustment spreadsheet (PH-CC-874) provided by the Owner for this purpose. The results will be given to the Contract Administrator, who, after having reviewed the results, verified the pay factors, and calculating the final payment adjustments, will provide them to the Contractor in accordance with the timelines stated in F31.

6-7.1 Localized Roughness (F31)

Combining localized roughness resulted from three runs can sometimes be challenging. The Smoothness Acceptance and Price Adjustment spreadsheet (PH-CC-874) includes a Worksheet entitled "Guideline" that provides guidelines to the profiler operator on combining localized roughness resulted from three profiler runs. These "Guidelines for Populating MTO's Smoothness Excel Spreadsheet for Localized Roughness" are also provided at the end of Appendix D: ProVAL .

6-8 Responsibilities of the Contract Administrator (CAITM)

Since surface smoothness is included as part of the Construction Administration and Inspection Task Manual (CAITM), the Contract Administrator has several responsibilities related to the administration of the smoothness specification based on measurements taken by high-speed inertial profilers. Task BIT 13 of the CAITM includes details of such responsibilities.

In addition to the responsibilities and deliverables listed in the CAITM, the Contract Administrator should:

1) Identify whether profiler reflectors can be placed on the right or median shoulders without a need for traffic lane closures. Placement/removal of the reflectors is the responsibility of the Contractor. In the event traffic lane closures are inevitable for the purpose of placement/removal of the reflectors **or collection of static GPS coordinates**, then the Owner will pay the cost of such lane closures as a change in work.

2) Confirm that the reflectors have been placed at the exact start/end stations identified in the sublot sketch for each profiler run. Each profiler run cannot be longer than 2,000 m.

3) In the event the profiler is equipped with GPS-DMI technology, discuss with the profiler operator the locations where static GPS is to be collected. At this stage of the technology, it is preferred that the static GPS locations are not more than **2** km apart, unless the highway is straight and longer distances are justified by the profiler operator.

4) Notify the profiler operator that they should only use automatic triggering for the start and end of each measurement and that manual triggering is not allowed.

5) During surface smoothness measurements, the Contract Administrator should be available to discuss any concerns raised by the profiler operator. If the Contract Administrator receives complaints from the Contractor or is otherwise not satisfied with the performance of the profiler operator, then he/she should inform the appropriate Regional Quality Assurance Section to discuss the issue.

Chapter Seven

ACCEPTANCE OF HOT MIX ASPHALT BASED ON AREA IN SQUARE METRES

7-1 General (F01)

This chapter describes the acceptance of Hot Mix Asphalt (HMA) items based on area in square metres laid rather than tonnage. Contracts where this applies will include items containing the words “Lift Thickness”. Such Contracts will be referred to as “Payment by Square Metre” or “PSM” Contracts in this Field Guide. The acceptance of HMA based on area in square metres is included in Special Provision 103F01 which deletes and replaces OPSS.PROV 313. For the purposes of this chapter, Ontario Provincial Standard Specifications (OPSS) and Special Provisions will be referred to as detailed in section 1-1.

Since many of the procedures described in previous chapters will still apply, this chapter will only direct the reader to the appropriate chapter and section and highlight changes that are applicable to the PSM items.

7-2 Sampling for Square Metre Items (F01)

7-2.1 Sampling for Lift Thickness (F01)

See section 2-6 for sample size, sampling frequency, sampling method, and random sampling location requirements for lift thickness.

Note that one core that goes through all the lifts is normally all that is required per sublot (taken after all lifts are placed in a location). This single core per sublot is used to determine the lift thicknesses of all the square metre items placed in this location.

7-2.2 Sampling Mix Properties and Compaction for Square Metre Items (F01)

See section 2-4.2.1 for lot and sublot sizes in square metres.

See section 2-4.3.2 for determining random sampling locations for square metre items.

7-3 Acceptance of Square Metre Items (F01)

7-3.1 Acceptance of Lift Thickness (F01)

See section 3-4 for reporting lift thickness (PH-CC-870) and guidance using the Thickness ERS Payment Adjustment Calculation spreadsheet (PH-CC-869). See section 5-2.3 for acceptance of lift thickness.

When multiple binder lifts of the same mix type are placed in succession, they are individually evaluated to ensure the minimum thickness was placed for each. When this is met, the combined thickness of all the binder lifts of the same mix type is then compared to the minimum sublot thickness for the total design thickness of the combined lifts. When a payment reduction applies to a binder lift, the Contract Administrator should consider the total pavement thickness of the lot.

For example:

Course	Mix Type	Design Thickness	Lot Mean Thickness	Minimum Thickness	Payment	Combined Lift Thickness
Surface	Superpave 12.5	40 mm	42 mm	30 mm	Full Payment	42 mm
Upper Binder	Superpave 19.0	50 mm	40 mm	40 mm	**Payment Reduction?**	108 mm
Lower Binder	Superpave 19.0	60 mm	68 mm	42 mm	Full Payment	

If we consider the above example, the lot mean of the combined binder course would be 108 mm (less than the design thickness of 110 mm). However, the total thickness (surface and binder) would meet the 150 mm (42 mm +108 mm) specified as the total design thickness (40 mm + 50 mm + 60 mm). In this case, the Contract Administrator should consult the Regional Quality Assurance Section to consider no payment reduction in cases like this.

7-3.2 Acceptance of Mix Properties and Compaction for Square Metre Items (F01)

See section 5-2.2.2 for acceptance of gradation, Asphalt Cement (AC) content, air voids, compaction, and VMA for square metre items.

See section 3-3.2 for changes to the ERS Hot Mix Asphalt Pay Factor Calculation Spreadsheet (PH-CC-868_103F01) for determining payment factors for gradation, AC content, air voids, compaction, and VMA for square metre items.

7-4 Referee Testing for Lift Thickness (F01)

See section 5-3.5 for referee testing of lift thickness measurements.

7-5 Repairs for Lift Thickness (F01)

See section 5-4.2 for repairs and re-evaluating for lift thickness.

Chapter Eight

ACCEPTANCE OF TACK COAT

8-1 General (308)

This chapter covers the acceptance of tack coat items according to OPSS.PROV 308 hereafter referred to as "308".

8-2 Products (308)

The specified product for tack coating consists of SS-1 emulsion, which is diluted 50:50 with water (usually by the Contractor rather than the supplier). Any deviation from this requires a written proposal from the Contractor approved by the Contract Administrator as specified in 308 and chapter 1 section 1-2.5.1 of this Field Guide.

8-3 Application (308 & 308F02)

Which lifts of construction are to be tack coated is specified in 308. In general terms, all existing, milled, expanded asphalt, and Cold In-place Recycled (CIR) surfaces and protection board will require tack coating. Additional areas may be specified in Special Provision 308F02. The surface to be tack coated must be free of contamination and standing water.

There are three different rates of application specified:

a) 0.50 kg/m^2 **(0.50 L/m^2)** for protection board,
b) 0.35 kg/m^2 **(0.35 L/m^2)** for existing surfaces, milled surfaces, full-depth reclamation with expanded asphalt stabilization surfaces, and the surfaces of any binder course travelled over the winter, and
c) 0.20 kg/m^2 **(0.20 L/m^2)** for CIR surfaces, Cold In-place Recycled Expanded Asphalt Mix (CIREAM) surfaces, and binder course surfaces constructed in the same calendar year (when required).

8-4 Sampling of Tack Coat (308)

1. The total tender quantity of tack coat used on the Contract shall be divided into one to three lots with one lot for each specified application rate. The lots shall be divided into sublots of 40,000 m^2.

2. The samples are taken at the paving site in the presence of the Contract Administrator or his representative in accordance with AASHTO T 40 and ASTM D3665. The Contractor is required to take two 1-litre samples (cans) of tack coat (one 1-litre sample for Quality Assurance (QA) testing and one 1-litre sample for possible referee testing) which are randomly chosen within each sublot.

An example of random sampling for tack coat is given below:

When two lanes (East/West) of 3.75 m in width between Sta. 10+000 and Sta. 24+425 are to be tack coated at a rate of 0.35 kg/m^2, tack coat sampling shall proceed as follows:

Example: Tack coat in lot 1 (rate of 0.35 kg/m^2) to have a set of two 1-litre samples (cans) obtained from each 40,000 m^2 sublot.

Determine the sublots for the lot (application rate of 0.35 kg/m^2) as follows:

Total Area of placement: (24425-10000) X 3.75 X 2(lanes) = 108,187.5 m^2
Length of each sublot: 40,000 ÷ 3.75 m = 10,666.66 m (rounded to nearest m)

Sublot	1	10 + 000 -	20 + 667	**Eastbound**
	2	20 + 667 -	24 + 425 (14,092.5 m^2)	
	2	24 + 425 -	17 + 516 (25,908.75 m^2)	**Westbound**
	3	17 +516 -	10 + 000	

For each sublot, the Contract Administrator either must select a random number from a random number table or generated by a calculator or computer. A table of random numbers is given in Appendix A: .

sublot 1	0.767
sublot 2	0.241
sublot 3	0.548

Sublot 1 random # X length of sublot = Distance into sublot
0.767 X 10667 = 8181.6 m or
Sta. 10+000 + 8182= Sta. 18+182

For Sublot 1, two 1-litre samples of tack coat will be taken @ Sta. 18+182 EB.

Sublot 2 random # X length of sublot = Distance into sublot
0.241 X 10667 = 2570.7 m or
Sta. 20+667 + 2571= Sta. 23+238

For Sublot 2, two 1-litre samples of tack coat will be taken @ Sta. 23+238 EB.

Sublot 3 random # X length of sublot = Distance into sublot
0.548 X 7516 = 4118.8 m or
Sta. 17+516 - 4119 = Sta. 13+397

For Sublot 3, two 1-litre samples of tack coat will be taken @ Sta. 13+397 WB.

3. After the samples have been taken, the Contract Administrator must immediately take possession of the QA and referee samples (for testing by the QA laboratory). Packing material should be placed around the cans to try to keep them upright and so that they do not knock against one another and become uncovered. Any relevant information (such as Contract number, application rate, Security Seal MTO code, date, station etc.) should be written on the bags using a regular permanent magic marker. Other relevant paperwork associated with the samples may be placed in the bags such as the Bituminous Material Product Sample Form (PH-CC-349) filled out by the Contract Administrator, reviewed by the Contractor, and signed by both. The Contract Administrator's representative should seal the

bags with a Security Seal (tie wrap) which has a customized MTO code (again the same type of ties being used for Hot Mix Asphalt).

4. Once sealed, the QA and referee samples can be delivered to the QA laboratory as specified in the Contract Documents.

5. The QA laboratory will unseal the samples and note down the security number, which must be reported along with the test results (if the sample is tested). The referee sample and any untested QA samples will be stored.

8-4.1 Extra Core Samples for Alternative Tack Coat

It is requested that three extra cores (150 mm diameter with an underlying lift) be taken when an alternative tack coat is used. The extra cores should be delivered to the MERO Bituminous laboratory for tack coat bond strength testing for information purposes.

8-5 Acceptance of Tack Coat (308)

8-5.1 Acceptance of Tack Coat based on Visual Observation (308)

The Contract Administrator shall reject any visually defective material or work whether or not the test results are rejectable. The defective material or work will not be incorporated into the finished work. If the tack coat coverage is insufficient or non-uniform, the Contractor should be required to re-spray the area.

The Contract Administrator must ensure that the distribution is uniform both transversely and longitudinally and that the full lane width being paved is tack coated. Too much tack coat is not desirable as it can migrate through the mix and result in fat spots or, in extreme cases, pavement flushing.

If the specified application rate appears inappropriate (i.e. results in excessive runoff or does not appear to create an asphalt film, which is thick enough), the applicable Regional QA Section should be contacted to review the application rate in conjunction with the Bituminous Section.

Tack coat has set when the colour changes from brown to black and is tacky when touched (i.e. it breaks or sets). Once the tack coat has set, the Contractor may place the Hot Mix Asphalt (HMA). Traffic should not travel upon the tack coat.

8-5.2 Acceptance of Tack Coat based on Test Results (308)

Acceptance is based on the results of the residue by distillation test (LS-216) for each sublot. **Penetration test on the residue in accordance with LS-200 shall also be performed by the QA laboratory on the diluted product for each sublot of tack coat for information purposes.**

Acceptable - percent residue by distillation ≥ 27.5%
Accepted with payment adjustment - percent residue by distillation < 27.5 and ≥ 20%
Accepted with no payment for the sublot - percent residue by distillation < 20%

See section 8-7 for payment adjustment calculations.

Note 8-1: Since most SS-1 emulsions are produced at or above 45:55 (45% water and

emulsifying agent to 55% asphalt) and the Contractor may dilute them further by 50:50, the resulting tack coat should contain at least 27.5% asphalt (55% x 50% = 27.5%).

8-6 Referee Testing for Tack Coat (308)

Referee testing for percent residue by distillation may be requested by the Contractor within two Business Days of receiving the test results for the sublot in question. Referee testing will be carried out as in sections 5-3.1 and 5-3.2. Results of referee testing shall be used in the calculation of the payment adjustment.

If the percent residue by distillation as determined by the referee laboratory is < 27.5%, the Contractor shall bear the cost of the referee testing. If the referee result is ≥ 27.5% the Owner shall bear the cost of the referee testing.

8-7 Payment Adjustment for Tack Coat (308)

If the sublot **percent residue** is < 20%, no payment shall be made for that sublot and it shall not be included in the weighted lot mean.

All remaining accepted sublots will be included in the calculation of the weighted lot mean and used in the calculation of the payment adjustment.

The weighted lot mean shall be calculated as follows:

$$WM_{pro} = [(PR_1 \times A_1) + (PR_2 \times A_2) + \ldots + (PR_n \times A_n)] / [A_1 + A_2 + \ldots + A_n]$$

Where:

WM_{pro}	=	the weighted lot mean for the product
PR_n	=	Percent Residue for sublot n
A_n	=	the area of sublot n
n	=	the number of sublots

The payment adjustment for each lot shall be calculated as follows:

Payment Reduction = Area x Price x 0.5 [1.00 - Product Quality Payment Factor]

Where:

Area	=	the total area tack coated in the lot
Price	=	tender item price for the specified product or negotiated price for the alternative product
Product Quality Payment Factor	=	1.00 if $WM_{pro} \geq 27.5$ or 0.75 if $WM_{pro} < 27.5$ and ≥ 20

Chapter Nine

ACCEPTANCE OF BRIDGE DECK WATERPROOFING

IT SHOULD BE NOTED THAT EACH LOT MUST BE DECISIONED FOR WATERPROOFING MEMBRANE THICKNESS ACCEPTANCE BEFORE THE BRIDGE IS PAVED. THE CONTRACTOR MUST SIGN FORM PH-CC-129A PRIOR TO PAVING.

9-1 General

The acceptance/rejection criteria for bridge deck waterproofing are covered by OPSS 914 and by any applicable special provisions.

This section of the Guide has been prepared to assist field staff with the use of a statistically-based acceptance procedure for bridge deck waterproofing which includes a membrane thickness component, a membrane quality component, and a protection board thickness component.

The thickness acceptance/rejection criteria are based on measurements taken in the field for both the membrane and the protection board, while the membrane quality criteria are based on test results obtained at the Owner's laboratory. The waterproofing membrane components or criteria are combined to determine the acceptability of the waterproofing membrane.

Rounding-off should be carried out according to LS-100 given in Appendix B: LS-100 Method for Rounding Off of Data and Other Numbers.

The Contract Administrator shall inspect the work during installation to ensure that the protection board is properly bonded to the waterproofing membrane and that the waterproofing membrane is bonded to the concrete surface.

Uneven or very rough existing deck surfaces generally require additional surface preparation to obtain an acceptable surface finish for waterproofing. It is expected that the Contract Documents will have included provisions for addressing this if it is known in advance that the existing deck surface is uneven or rough. Otherwise the Head of the Regional Structural Section and the Concrete Section of the Materials Engineering and Research Office should be consulted for guidance on how to address this situation.

Note 9-1: Protection board thickness measurements shall be done on site prior to the commencement of the waterproofing operation. Protection board thickness will be accepted on a lot basis. Lot size for measurement of protection board thickness shall be the total number of protection boards required to cover the lot as defined for waterproofing membrane thickness and quality.

Note 9-2: Quality control measurement of thickness of waterproofing membrane is the Contractor's responsibility.

Note 9-3: Measure membrane thickness for acceptance testing after the complete construction of a lot (which includes the placement of protection boards). A lot for bridge deck waterproofing is a deck or part of a deck with an area of 800 m^2 or less (see OPSS 914).

Note 9-4: The test locations for waterproofing membrane thickness shall be calculated prior to the completion of the lot so that they may be laid out and measurements can be taken immediately after construction is completed. A second set of locations should also be calculated in case a re-test is required.

Note 9-5: Acceptance of the membrane thickness will be based on the mean thickness and standard deviation within a lot.

Note 9-6: Acceptance of the membrane quality shall be according to OPSS 914.

9-2 Measurement of Protection Board Thickness

Note 9-7: Protection board contains fibreglass, appropriate personal protective equipment shall be worn when taking measurements.

Step 1 – Lots

Protection board thickness measurement will utilize the same lots set up for evaluation of the waterproofing membrane. The lot size shall be the total number of protection boards required to cover the area of the lot for waterproofing membrane. The Contract Administrator shall randomly select one protection board per lot for measurement of protection board thickness. **The top and bottom protection boards on each pallet shall not be used for acceptance measurements.**

Step 2 – Measure Protection Board Thickness

2.1 Measurement of protection board thickness shall be made with digital calipers.

2.2 The calipers shall have a resolution of 0.01 mm.

2.3 Clean the external measuring faces of the caliper with a cloth.

2.4 Close the calipers so that the external measuring faces are touching. Press the zero button. Ensure that the calipers read 0.00 mm when fully closed. If the calipers do not read 0.00 mm when fully closed, the calipers should not be used and should be replaced with one that is functioning properly.

2.5 Prior to measurement, remove any sand or other loosely adhered particles around the perimeter of the protection board with a cloth.

2.6 Take a measurement of the protection board thickness along one side of the protection board by gently closing the external measuring faces of the calipers**, ensuring that the pressure applied to the calipers does not compress the protection board.** Calipers should be perpendicular to the protection board when measuring. Record the measurement to the nearest 0.01 mm.

2.7 A total of 12 thickness measurements evenly distributed around the perimeter of the protection board (three on each side) shall be taken and recorded on Form PH-CC-129A.

Step 3 – Acceptance Determination

The lot is acceptable if the average of the 12 thickness measurements rounded to the nearest 0.1mm is equal to or greater than 3.2 mm and less than or equal to 4.0 mm.

The entire lot is rejected and shall not be used in the work if the average of the 12 thickness measurements rounded to the nearest 0.1 mm is less than 3.2 mm or greater than 4.0 mm. The lot of protection board shall be removed and replaced with new protection board at the Contractor's expense. After the replacement is made, a randomly selected board will be taken to represent the new lot and new measurements taken as described in Step 2 to confirm the new lot is within the acceptable tolerances.

9-3 Sampling and Testing of Waterproofing Membrane Thickness

9-3.1 Waterproofing Membrane Thickness Acceptance Procedure

Membrane thickness acceptance procedure will be discussed by working through the following example:

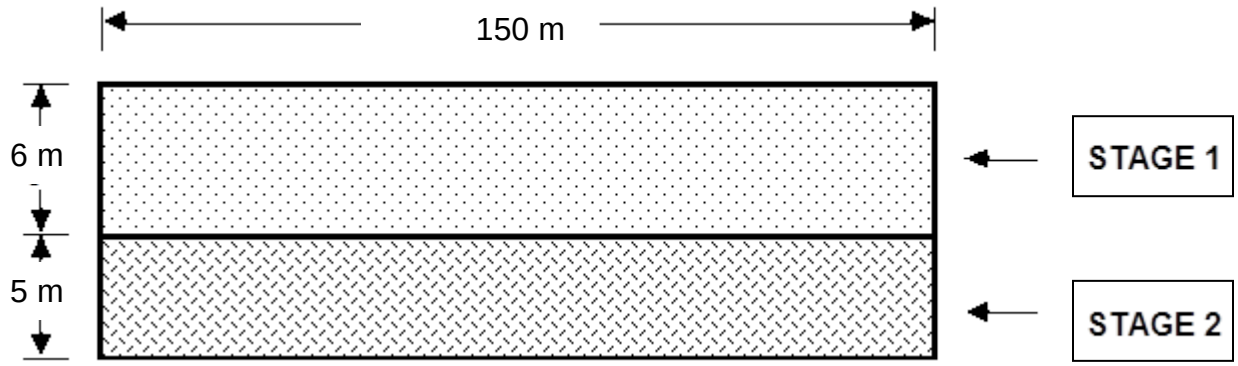
Steps:

1. Compute the area of the deck (by stages).
2. Determine lot size(s) to the closest 0.1 m^2 and assign lot numbers.
   Number lots consecutively per structure through all stages of construction. No structure (site) number should have any duplicate lot numbers.
3. Select random numbers.
4. Determine test locations to the closest 0.1 m.
5. Measure and record the waterproofing membrane thickness at each test location.
6. Computations.
7. Acceptance determination.
8. Referee testing.
9. Basis of payment.

Example

A bridge deck 150 metres long by 11 metres wide is to be waterproofed in two stages in order to maintain traffic on one side. The Contractor wishes to waterproof 6 metres wide on the first side.

Figure 9-1: Example of Bridge Deck Stages



Step 1 Compute area of deck (by stages)

Stage 1: 6 x 150 = 900 m^2
Stage 2: 5 x 150 = 750 m^2
Total = 1650 m^2

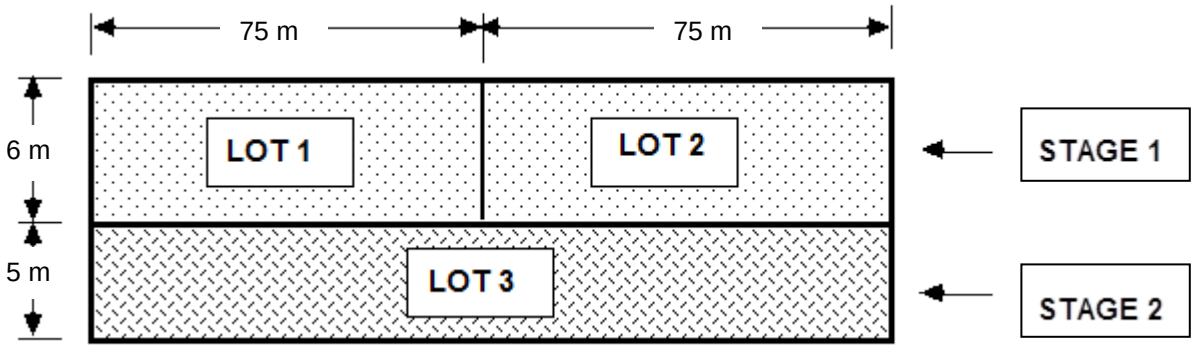
Step 2 Determine lot sizes to the closest 0.1 m^2 and assign lot numbers

Since the first stage will be in excess of 800 m^2, it must be divided into two equal lots, each 75 metres long.

The second stage, which has an area under 800 m^2 (i.e. criteria 2), is considered to be a single lot which is numbered lot 3, not lot 1 stage 2.

Note 9-8: If the deck is of irregular shape, the lot sizes should be roughly equal in area.

Figure 9-2: Example Bridge Deck Lots



Step 3 Select random numbers

The test locations are obtained by using random numbers.

From a random number table select two sets of ten random numbers from a vertical column or horizontal row. See Appendix A: Random Number Table or Sample Random Number Table below.

.958	.863	.912	.012	.219	.201	.384	.291	.661	.633
.142	.784	.288	.910	.049	.644	.327	.345	.535	.310
.433	.412	.427	.996	.174	.318	.931	.006	.345	.263
.717	.976	.232	.083	.936	.094	.092	.391	.953	.688
.919	.370	.939	.575	.765	.539	.619	.308	.705	.829
.324	.637	.533	.659	.026	.617	.348	.218	.935	.463
.015	.004	.485	.594	.102	.942	.726	.295	.328	.489
.870	.204	.854	.547	.527	.552	.958	.454	.024	.689
.433	.152	.722	.656	.224	.358	.385	.667	.156	.647
.082	.502	.347	.393	.303	.295	.637	.307	.507	.689
.119	.057	.188	.474	.713	.138	.689	.004	.255	.903
.297	.713	.871	.658	.215	.353	.876	.045	.765	.864

Sample Random Number Table

The numbers in the rows/columns will be used to determine the distance from the end of the lot and the offset location from one edge of the lot.

Note 9-9: Avoid using the same rows/columns when calculating a second set of test locations.

Step 4 Determine test locations to the closest 0.1 m

To determine the length (Ls) of each sublot, divide the length of the lot by ten. The distance into each sublot is then determined by multiplying Ls by a random number.

The offset from one side of the lot is determined by multiplying a random number by the width of the lot.

Example: Sample Locations for Lot No. 1

Ls = 75 ÷ 10 = 7.5 m; Length of each sublot is therefore 7.5 m.

Sample No.	Start Sublot	+	(Ls x Random No.)	=	Dist. (m)	Width	x	Random No.	=	Offset (m)
1	0.0	+	(7.5 x .919)	=	6.9	6	x	.661	=	4.0
2	7.5	+	(7.5 x .370)	=	10.3	6	x	.535	=	3.2
3	15.0	+	(7.5 x .939)	=	22.0	6	x	.345	=	2.1
4	22.5	+	(7.5 x .575)	=	26.8	6	x	.953	=	5.7
5	30.0	+	(7.5 x .765)	=	35.7	6	x	.705	=	4.2
6	37.5	+	(7.5 x .539)	=	41.5	6	x	.935	=	5.6
7	45.0	+	(7.5 x .619)	=	49.6	6	x	.328	=	2.0
8	52.5	+	(7.5 x .308)	=	54.8	6	x	.024	=	0.1
9	60.0	+	(7.5 x .705)	=	62.3	6	x	.156	=	0.9
10	67.5	+	(7.5 x .829)	=	73.7	6	x	.507	=	3.0

The computed distances and offsets are then copied into the appropriate columns on Form PH-CC-129A.

Step 5 Measure and record waterproofing membrane thickness at each test location

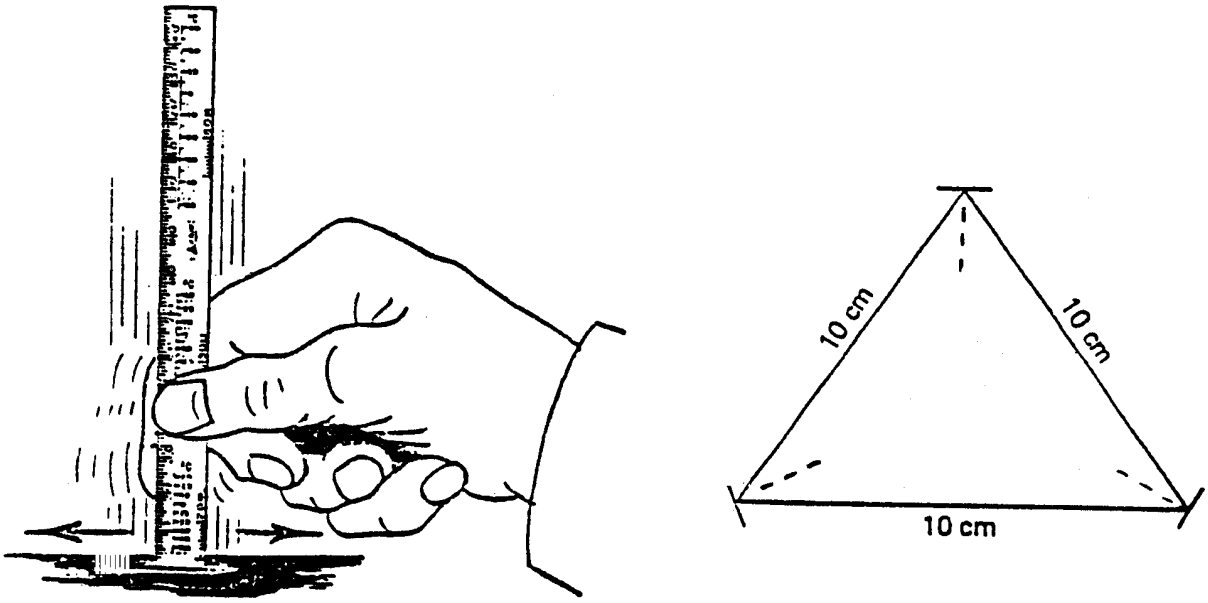
Mark out each computed test location on the deck as soon as construction of the lot is completed.

Select the closest upper corner of a protection board to your sample location. Lift up the corner of the board to expose a triangle of membrane approximately 15 cm per side.

If a test location coincides with the placement of membrane reinforcement, a new random location must be determined for that sublot, to avoid the reinforced area.

The measurement is made with a thin steel scale, such as that supplied with a surveyor's chain for temperature correction or a machinist scale obtained at most hardware stores. The zero end of the scale is worked back and forth in a sawing action until it is in contact with the concrete deck. The thickness of the membrane may then be read directly off the scale. Take three readings, at each location, at the points of an imaginary equilateral triangle with approximate sides of 10 cm. These measurements should be made perpendicular to the bisector of the interior angle, as shown in the diagram below. Average the results of the three readings and round to the closest millimetre using the method shown in Appendix B: LS-100 Method for Rounding Off of Data and Other Numbers. Record the result on Form PH-CC–129A. (see Figure 9-3).

Figure 9-3: Measuring Waterproofing Membrane Thickness



Note 9-10: The end of the scale must be equal to zero.

Step 6 Computations

1. Add the 10 thickness measurements (T) and record the sum in the box ∑T on Form PH-CC-129A (see example filled out form in Figure 9-4).

2. Square the sum (∑T) and record in the Sum^2 box $(\sum T)^2$ (below the ∑T box).

3. Divide the sum (∑T) by 10 and enter the result, accurate to one decimal place in the Mean box.

4. Square each thickness (T) and enter in the thickness^2 column T^2.

5. Add the 10 thickness^2 (T^2) and enter in the sum of thickness^2 box ($\sum T^2$).

6. Enter the information from the appropriate boxes into the formula for standard deviation and calculate to four decimal places and then round off to the closest 0.05 using the appropriate rounding procedure shown in see Appendix B: LS-100 Method for Rounding Off of Data and Other Numbers.

7. From Table 9-1 (available at the end of this section or Table 1 in OPSS 914), determine the pay factor from the intersection of the mean in the vertical columns and the standard deviation in the horizontal rows and enter on the appropriate line.

Step 7 Acceptance determination

The decision to accept the waterproofing membrane thickness shall be based on the mean and standard deviation of each lot.

If the lot mean is less than 4.0 mm or greater than 6.0 mm, the entire lot is rejectable and the Contractor shall remove and replace the lot according to the Treatment of Rejectable Lots clause of OPSS 914.

If the lot mean is greater than or equal to 4.0 mm and less than or equal to 6.0 mm, the mean and the standard deviation shall be rounded to the closest 0.1 mm and 0.05 mm respectively, and shall then be applied to Table 9-1 to determine if the lot is in the acceptable, marginal, or rejectable range. If the lot is within the marginal range of Table 9-1, the Contractor may repair the lot as outlined below, or request that the Owner accept the lot as is, with a payment adjustment as outlined in the Payment Adjustment Due to Membrane Thickness Deficiency clause. If the lot is within the rejectable range of Table 9-1, the Contractor shall remove and replace the lot according to the Treatment of Rejectable Lots section of OPSS 914.

Where the membrane thickness is greater than 6.0 mm, the Contractor may submit a proposal in writing for an alternative to removal and replacement for rejectable waterproofing membrane thickness, for the Owner's consideration.

Note 9-11: Prior to a decision on the disposition of the lot, the Regional Quality Assurance Section must be consulted.

Step 8 Referee testing

The Contractor may request referee testing, prior to paving and within 2 Business Days of being advised of test results, if any or all of the ten sublot test values are challenged. If this occurs, 10 new thickness measurements shall be taken within the lot by the Contract Administrator in the presence of the Contractor. The new test values shall then be used to determine acceptance. Acceptance shall be based on the criteria specified in the Membrane Thickness Acceptance Determination section of OPSS 914 and shall be binding on both parties.

If the referee testing results in either a marginal or a rejectable lot, the Contractor shall bear the cost of the referee testing. If the referee testing results in the material passing thickness testing criteria and resulting in an acceptable lot, the referee testing charge shall be paid by the Owner.

Step 9 Basis of payment

If the lot is considered acceptable, the Contractor will be paid the Contract price for the lot as bid. If the lot is marginal, the lot mean and the lot standard deviation will be applied according to Table 9-1, in order to determine the thickness payment adjustment factor. Such thickness payment adjustment factor will then be multiplied by the Contract price for the area of the lot, in order to determine payment. In the case of lump sum price, the price of the lot must be prorated before applying the thickness adjustment factor.

Figure 9-4: Example Waterproofing Membrane Thickness Report

Ontario Ministry of Transportation

PROTECTION BOARD AND WATERPROOFING MEMBRANE THICKNESS REPORT REPORT No. 1 of 3

CONTRACT No. 2015-30XX REGION West HWY. No. 401 SITE No. 8-466

AREA OF DECK 1650 m^2
PROTECTION BOARD MANUFACTURER Superboard
PROTECTION BOARD PRODUCT NAME Superboard
MANUFACTURER'S LOT NUMBER(S) AND DATE OF MANUFACTURE FOR PROTECTION BOARD Lot 68-347 (May 1, 2015)
MEMBRANE MANUFACTURER Superplastic II WATERPROOFING CONTRACTOR Torrid Waterproofing

LOT No. 1 OF 3 AREA OF LOT 550 m^2

PROTECTION BOARD THICKNESS (mm)

	Side 1	Side 2	Side 3	Side 4
Measurement 1 (mm)	3.4	4.1	3.3	3.8
Measurement 2 (mm)	3.6	3.7	3.1	3.3
Measurement 3 (mm)	3.9	3.7	3.6	3.9
Average Protection Board Thickness (average of 12 measurements of one board) (mm)				3.6

WATERPROOFING MEMBRANE THICKNESS

☐ FIRST TEST ☐ RETEST

SUBLOT No.	DISTANCE (m)	OFFSET (m)	THICKNESS (mm)	T^2 (mm^2)
1	6.9	4.0	4	16
2	10.3	3.2	4	16
3	22.0	2.1	5	25
4	26.8	5.7	4	16
5	35.7	4.2	5	25
6	41.5	5.6	4	16
7	49.6	2.0	5	25
8	54.8	0.1	5	25
9	62.3	0.9	6	36
10	73.7	3.0	5	25
		Sum	ΣT 47	(ΣT^2) 225
		Sum^2	2209	
		Mean = Sum/10	4.7	

$$St.Dev. = \sqrt{\frac{n*(\Sigma T^2)-(\Sigma T)^2}{n*(n-1)}}$$

$$= \sqrt{\frac{10 * 225 - 2209}{90}} = \sqrt{0.4555} = 0.6749 = 0.68$$

ADJUSTMENT FACTOR 1.0

THE PROTECTION BOARD THICKNESS FOR THIS LOT IS: ☐ ACCEPTABLE ☐ REJECTABLE	
THE WATERPROOFING MEMBRANE THICKNESS FOR THIS LOT IS: ☐ ACCEPTABLE AND WILL BE PAID AT THE CONTRACT PRICE ☐ MARGINAL, MAY BE LEFT IN PLACE AT THE ADJUSTED PRICE ☐☐REJECTABLE, IT MUST BE REPAIRED CONTRACT ADMINISTRATOR ACKNOWLEDGED BY CONTRACTOR DATE 10 18 2015	☐ THIS LOT FALLS IN THE MARGINAL ZONE. I REQUEST THE ABOVE ADJUSTMENT FACTOR BE APPLIED TO THIS LOT. ☐ I WILL REPAIR THIS LOT PRIOR TO RETESTING ☐ I REQUEST RETESTING CONTRACTOR DATE 10 18 2015

Distribution: 1.CONTRACT ADMINISTRATOR 2.CONTRACTOR 3.REGIONAL QUALITY ASSURANCE 4.HO CONCRETE SECTION
PH-CC-129A April 6, 2016

Table 9-1:
Acceptance Determination and Payment Adjustment Factors Membrane Thickness

Lot Standard Deviation	Lot Mean													Lot Standard Deviation
	4.0	4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.8	4.9	5.0	5.1	5.2	
0.0														0.0
.05														.05
.10														.10
.15														.15
.20														.20
.25														.25
.30														.30
.35														.35
.40														.40
.45	Acc													.45
.50	.99	Acc												.50
.55	.94	.99	Acc											.55
.60	.83	.95	.99	Acc										.60
.65	Rej	.86	.95	.99	Acc									.65
.70	Rej	.59	.87	.96	.99	Acc								.70
.75		Rej	.71	.89	.96	.99	Acc							.75
.80			Rej	.76	.91	.96	.99	Acc						.80
.85				Rej	.81	.91	.96	.99	Acc	Acc				.85
.90					Rej	.83	.92	.97	.99	.99	Acc			.90
.95					Rej	.64	.84	.93	.97	.99	.99	Acc		.95
1.00						Rej	.71	.87	.93	.97	.99	.99	Acc	1.00

Table 1 continued on next page.

Table 9-1: (Cont'd)
Acceptance Determination and Payment Adjustment Factors Membrane Thickness

Lot Standard Deviation	Lot Mean																Lot Standard Deviation
		4.6	4.7	4.8	4.9	5.0	5.1	5.2	5.3	5.4	5.5	5.6	5.7	5.8	5.9	6.0	
	1.05	Rej	.76	.87	.94	.97	.99	.99	Acc								1.05
	1.10		Rej	.79	.89	.94	.97	.99	.99	Acc							1.10
	1.15		Rej	.59	.81	.90	.95	.97	.99	.99	Acc						1.15
	1.20			Rej	.64	.83	.91	.95	.97	.99	.99	Acc					1.20
	1.25				Rej	.71	.84	.91	.95	.97	.99	.99	Acc				1.25
	1.30					Rej	.76	.86	.92	.95	.97	.99	.99	Acc			1.30
	1.35						Rej	.77	.87	.92	.95	.98	.99	.99	Acc		1.35
	1.40						Rej	.59	.79	.87	.93	.96	.98	.99	.99	Acc	1.40
	1.45							Rej	.68	.82	.88	.93	.96	.98	.99	.99	1.45
	1.50								Rej	.71	.83	.89	.93	.96	.98	.99	1.50
	1.55									Rej	.74	.84	.90	.94	.96	.98	1.55
	1.60										Rej	.78	.86.	91.	.94	.96	1.60
	1.65										Rej	.64	.79	.87	.91	.94	1.65
	1.70											Rej	.68	.81	.87	.91	1.70
	1.75												Rej	.71	.82	.87	1.75
	1.80													Rej	.74	.83	1.80
	1.85													Rej	.59	.76	1.85
	1.90														Rej	.64	1.90
	1.95															Rej	1.95
	2.00															Rej	2.00

Notes:

A. Cells containing the Payment Adjustment Factors form the marginal range.

B. "Acc" means acceptable.
C. "Rej" means rejectable.

9-4 Sampling and Testing of Waterproofing Membrane Quality

9-4.1 Summary of Waterproofing Membrane Quality Acceptance Procedure

Samples of waterproofing material must be placed in a metal container (not plastic) such as a 4 L unused metal "Paint Cans". The container shall be clean and free of debris.

The decision to accept the quality component of the waterproofing membrane will be based on the results of tests performed in accordance with OPSS 1213. Acceptance is according to OPSS 914.

A lot will be considered acceptable, if all specification requirements are met.

A lot will be considered marginal and subject to payment adjustment, if the total number of adjustment points resulting from Table 9-2 (or Table 2 in OPSS 914) are greater than 0 and less than or equal to 20.

A lot will be considered rejectable, if any of the following criteria are met:

1) The total number of adjustment points is greater than 20.

2) Any test result for a sample is in the rejection value range, as shown in Table 9-2 (or Table 2 of OPSS 914).

Note 9-12: A lot is rejectable if the test sample fails the low temperature flexibility test at -25 °C, as indicated in Table 9-2 or Table 2 of OPSS 914.

Table 9-2: Acceptance Determination and Payment Adjustment Factors for Membrane Quality

Test	Specification Limits	Marginal Range (B)	Adjustment Points	Rejection Value
Low Temperature Flexibility at -25 °C	Pass	N/A	N/A	Fail
Cone Penetration at 25 °C (0.1 mm)	Max. 110	111 to 130	P1 = 0.4*(B-110)	> 130
Cone Penetration at 50 °C (0.1 mm)	Max. 160	161 to 180	P2 = 0.4*(B-160)	> 180
Flow at 60 °C (mm)	Max. 3 mm	3.1 to 5.0	P3 = 4*(B-3)	> 5.0
Toughness (joules)	Min. 5.5	5.4 to 4.0	P4 = 5*(5.5-B)	< 4.0
Toughness/Peak Force (joules/newton)	Min. 0.040	0.039 to 0.030	P5 = 500*(0.040-B)	< 0.030
PT (adjustment points) = P1 + P2 + P3 + P4 + P5				

Note: B is an observed test result within the marginal range to be used for calculation of adjustment points.

Below are the steps to be followed in the field:

Steps:
1. Determine when to obtain the sample
2. Obtain the sample

3. Label the sample
4. Place the sample in a bag and apply security tag.
5. Complete Field Sample Data Sheet (PH-CC-340), see details below)
6. Ship the sample
7. Compute the quality adjustment factor
8. Compute final payment for the lot

9-4.2 Payment Adjustment for Waterproofing Membrane Quality

Example

Step 1 Determine when to obtain the sample

Take the first random number used in determining the distance into the first sublot for the determination of the membrane thickness and calculate when to obtain the sample as follows:

In the previous example, this number was 0.919.

The first digit is used to identify in which sublot the sample will be taken and the second digit is used to identify how far into the sublot it will be taken.

e.g. .919 - 9th Sublot
10% into sublot

.370 - 3rd Sublot
70% into sublot

.024 - 10th Sublot
20% into sublot

Step 2 Obtain the sample

A full 4 L of material is required for laboratory testing (if insufficient sample size is submitted, no referee testing can be performed). Suitable containers are clean, unused, 4 L metal containers such as "Paint Cans" with double tight lids. The container must be full and contain 4 L of material in order to have sufficient sample retained for referee testing, if requested. They shall be placed on the container immediately after sampling, the sample does not have to be cool at the time it is sealed.

When the Contractor reaches the desired sublot and has waterproofed the approximate percentage of it; a sample shall be taken by the Contractor in the presence of the Contract Administrator and set out of the way. The Contractor is not to be advised ahead of time, when the sample is to be taken.

Step 3 Label the sample

It is very important that the sample be completely and clearly identified. Use the Field Sample Data Sheet – Concrete (PH-CC-340) and make sure it contains the following information:

1. Contract number,
2. Region,
3. Name of membrane manufacturer,
4. Membrane product name,
5. Date the material was delivered to site,
6. Batch number(s) from manufacturers containers,

7. Temperature of material when sampled from melter,
8. Ambient air temperature,
9. Concrete surface temperature,
10. Inspector's name,
11. Date sampled,
12. Field Sample Number,
13. MTO security tag number,
14. What lot the sample is from and the total number of lots on the deck,
15. Name of waterproofing Contractor,
16. Structure site number.

Place the Field Sample Data Sheet – Concrete (PH-CC-340) in an envelope and then in the bag and fasten it securely to the sample.

Step 4 Ship the sample

Samples shall be delivered within 5 Business Days of the application date.

Send the sample to:
Head, Concrete Section
Ontario Ministry of Transportation
Room 15
145 Sir William Hearst Avenue
Downsview, Ontario
M3M **0B6**

Step 5 Compute the quality adjustment factor

Quality pay adjustment factors are calculated as follows:

1. If the sample test results meet all of the specification limits outlined in Table 2 of OPSS 914, then assign a payment adjustment factor of 1.00.

2. If the sample test results are within the marginal range for one or more tests, then total the adjustment points outlined in Table 2 of 914. The payment adjustment factor is then determined by subtracting the total of all of the adjustment points from 100 and then dividing the result by 100.

3. If the adjustment points exceed 20 or any individual test result falls within the rejection value range, then the lot is considered rejectatable and the Contractor will not be paid for the lot, regardless of the adjustment factor for thickness.

Figure 9-5: Example of Completed Field Sample Data Sheet - Concrete

Ministry of Transportation

FIELD SAMPLE DATA SHEET - CONCRETE

Contract or WP No. 2015-30XX Dist/Region West Region Date Sampled October 18/2015
Sampled By CA Consulting Eng./Torrid Waterproofing Phone No. 905-555-2020
Field Sample No. 12345 Results to: CA@consultingeng.com
Remarks: Hwy 401 – Bridge #5 Stage #1
Received at Lab: _____ Lab No. _____

Cement, Slag, Fly Ash, Blended Cement
Type of Cement (circle) 10 20 30 40 50 Slag Fly Ash SF Cement
Manufacturer Name _____ Cement Plant _____
Sampled from _____
Ready Mix. Co. Name _____ Ready Mix Co. location _____

Admixtures /Latex
Type of Product: Air Entraining Admixture ☐ Chemical (Including Superplasticizers) ☐
Latex ☐
Manufacturer Name _____ Product Name _____
Ready Mix Co. Location _____ Sampled from _____
Ready Mix Co. (or Mobile Mixer Operator) Name _____ Batch No. _____

Curing Compounds
Manufacturer Name _____ Product Name _____
Samples from a Nozzle _____ Sampled differently (describe) _____

Waterproofing Membrane
Manufacturer Name The Waterproofing Company Product Name Superlastic II Batch No. 532469
Sample Temperature 187°C Lot 1 of 3
Structure Site No. 8-466 Applicator Torrid Waterproofing

Joint Sealant
Manuf. Name _____ Product Name _____
Sample Temperature _____ Batch No. _____

Bearings/Expansion Joint Seals
Manufacturer _____ Product Name _____
Sample Location _____ Date Sampled _____ Lot No. _____
Identification No. _____ Structure Site No. _____

Hardened Concrete/Shotcrete Samples
Site No. _____ Age of Structure _____ Location in Structure _____
Additional information submitted ☐ or available ☐
Key Map ☐ Specimen location sketch ☐ Crack survey ☐ ½ cell survey ☐
Delamination survey ☐
Field Remarks _____
Testing Requested: Visual description ☐ Compressive Strength ☐ Absorption ☐
Air by linear traverse ☐ Composition ☐ Salt Scaling ☐ Chloride content ☐
Petrographic exam ☐ Modulus of elasticity ☐ Chloride permeability ☐ Tensile Strength ☐
Other _____

Distribution: 1) Testing Laboratory (2 copies) 2) Originator (1 copy)

PH-CC-340 Aug-09

9-4.3 Referee Testing for Waterproofing Membrane Quality

The Contractor may request, in writing, referee testing of any sample that results in payment adjustment or rejection of a lot; however, the request shall be made within 5 Business Days of receiving notification of payment adjustment or rejection of the lot. The results of the referee test shall be used for acceptance determination and shall be binding on both parties. If the referee testing results in either a payment adjustment or rejection of the lot, the Contractor shall bear the cost of the referee testing. If the referee testing results in the material passing all test criteria, the referee testing charge shall be paid by the Owner.

e.g. Waterproofing Sample from Lot 1

Test		Result	Spec.	Reject
Low Temp. Flex.	@ -25 °C	Pass	Pass	Fail
Cone Pen.	@ 25 °C	105	Max. 110	>130
	@ 50 °C	174*	Max. 160	>180
Flow	@ 60 °C	4*	Max. 3	>5.0
Toughness		7.1	Min 5.5	<4.0
Toughness/Peak Force		0.038*	Min. 0.040	<0.030

In this example, the material failed 3 tests, and result is in the marginal range:

1. Cone Pen. @ 50°C by 14 units
2. Flow @ 60°C by 1 unit
3. Toughness/Peak Force by 2 units

The total adjustment per test is determined by the formulae in Table 2 of OPSS 914.

Cone Pen. @ 50°C	P2 = 0.4*(174-160)	=	5.6
Flow @ 60°C	P3 = 4*(4-3)	=	4.0
Toughness/Peak Load	P5 = 500*(0.040-0.038)	=	1.0
Total:			10.6

The total adjustment points (PT) for material quality is equal to the total of the individual test adjustments, in this case 10.6.

PT = P1 + P2 + P3 + P4 + P5 = 0 + 5.6 + 4.0 + 0 + 1.0 = 10.6

The quality adjustment factor is equal to:

(100 – 10.6)÷100 = 89.4÷100 = 0.894

See the example of a field sample test report form on the following page.

Step 6 Compute final payment for the lot

The final payment for the lot will be based on the thickness and on the quality of the waterproofing membrane. The Contract price for the lot shall be multiplied by the thickness adjustment factor and the result shall then be multiplied by the quality adjustment factor.

For this example, we will assume that the Contract price for the waterproofing is \$28.50/m^2.

Area Lot	=	450.0 m^2		
Contract price	=	450.0 X \$28.50	=	\$12,825.00
Thickness Adjustment Factor	=	1.00		
Adjusted price for thickness	=	\$12,825.00 X 1.00	=	\$12,825.00
Quality Adjustment Factor	=	0.894		
Adjusted price for quality	=	\$12,825.00 X 0.894	=	\$11,465.55
Credit to the Ministry	=	\$12,825.00 -\$11,465.55	=	\$1,359.45

Figure 9-6: Example of Completed Field Sample Test Report

FIELD SAMPLE TEST REPORT — File: 3321-2

HOT APPLIED RUBBERIZED ASPHALT WATERPROOFING MEMBRANE

To:	Contract Administrator West Region	From:	Materials Engineering & Research Office Concrete Section, Room 235 Building "C", Downsview Complex
		Date:	06-Mar-15
CC:		Tel:	
	Head, Quality Assurance Section		

CONTRACT #	2015-30XX	LABORATORY #	052318
REGION	West	DATE SAMPLED	10 18 2015
SITE #	8-466	DATE RECEIVED	11 22 2015
LOCATION	Hwy. 401	DATE COMPLETED	02 03 2015
PRODUCT	Superlastic II	FIELD #	1
APPLICATOR	Torrid Waterproofing	LOT #	1

TEST	SPECIFICATION LIMITS OPSS 914	TEST VALUES	DIFF. OUTSIDE SPEC. LIMIT	ADJUSTMENT POINTS	TOTAL ADJUSTMENT PER TEST	REJECTION VALUE OPSS 914
LOW TEMPERATURE FLEXIBILITY @ -25°C	Pass	Pass		Not applicable	Not applicable	Fail
CONE PENETRATION @ 25°C (0.1 mm)	Max. 110	105		P1 = 0.4*(B-110)		> 130
CONE PENETRATION @ 50°C (0.1 mm)	Max. 160	174	14	P2 = 0.4*(B-160)	5.6	> 180
FLOW @ 60°C (mm)	Max. 3	4	1	P3 = 4*(B-3)	4	> 5
TOUGHNESS (joules)	Min. 5.5	7.1		P4 = 5*(5.5-B)		< 4.0
TOUGHNESS / PEAK FORCE (joules / newton)	Min. 0.040	0.038	0.002	P5 = 500*(0.040 - B)	1.0	< 0.030
MASS DENSITY	Not applicable			TOTAL ADJUSTMENT POINTS (PT) PT = P1 + P2 + P3 + P4 + P5		10.6
				QUALITY ADJUSTMENT FACTOR = $\frac{100 - \text{TOTAL ADJUSTMENT POINTS}}{100}$		0.894

Notes
B = test value in marginal range
Lot is rejectable if PT is greater than 20 points or if any test value is in the rejectable value range.

REMARKS

cc.

Senior Concrete Materials Engineering Officer

9-5 Treatment of Rejectable Lots of Waterproofing Membrane

Removal of membrane material shall include removal of the full membrane thickness to neat lines, and removal of overlying pavement as applicable. Deck surface preparation, placement of a new tack coat, membrane material and membrane reinforcement over the removal area shall be completed according to OPSS 914. New membrane material shall be lapped according to the Application of Waterproofing Membrane clause of OPSS 914.

Any protection boards that are removed during the repairs and referee testing shall be replaced with new protection boards meeting specification requirements. **The Contract Administrator shall ensure that, after repairs, the protection board is properly bonded to the waterproofing membrane.**

Lots that have been repaired or replaced shall be subject Quality Assurance acceptance requirements of OPSS 914.

The Contractor shall be responsible for all costs associated with removing and replacing rejectable lots.

9-6 Sampling of Other Materials

In addition to the sampling discussed above, representative samples of the following shall be taken for quality assurance testing by the Owner, according to OPSS 914:

a) For each contract, a 1 litre sample of tack coat

b) For each contract, a 300 mm by 300 mm piece of waterproofing membrane reinforcement

c) For each contract, a 300 mm by 300 mm piece of protection board.

d) For each contract, a 1 litre sample of joint sealing compound.

The samples shall be delivered within five Business Days of the waterproofing application date to:

Head, Concrete Section
Ontario Ministry of Transportation
Room 15
145 Sir William Hearst Avenue
Downsview, Ontario
M3M **0B6**

APPENDICES

APPENDIX A: RANDOM NUMBER TABLE

.318	.801	.435	.202	.745	.489	.900	.027	.827	.279
.922	.683	.847	.320	.476	.421	.893	.826	.444	.619
.726	.473	.854	.662	.381	.761	.661	.868	.174	.799
.711	.341	.219	.228	.466	.683	.676	.327	.502	.469
.978	.631	.469	.885	.267	.510	.601	.135	.290	.025
.689	.152	.703	.533	.742	.335	.670	.521	.007	.590
.521	.351	.824	.854	.347	.792	.542	.590	.051	.713
.960	.690	.343	.019	.917	.876	.365	.271	.942	.355
.991	.530	.165	.042	.448	.626	.526	.926	.607	.827
.713	.765	.812	.496	.626	.770	.331	.770	.662	.200
.141	.266	.141	.919	.199	.520	.332	.526	.752	.991
.966	.697	.704	.305	.831	.842	.740	.050	.925	.239
.681	.637	.035	.023	.335	.799	.623	.673	.509	.480
.106	.702	.879	.408	.519	.929	.416	.584	.486	.818
.635	.427	.554	.288	.318	.983	.844	.858	.059	.851
.507	.673	.434	.163	.060	.375	.025	.514	.848	.637
.297	.057	.951	.411	.441	.564	.171	.693	.052	.063
.817	.663	.369	.038	.653	.001	.321	.506	.886	.920
.763	.580	.967	.071	.368	.351	.950	.098	.529	.793
.496	.290	.698	.183	.504	.687	.005	.814	.954	.356
.314	.490	.174	.925	.886	.170	.496	.453	.835	.546
.306	.360	.103	.152	.234	.654	.941	.108	.980	.439
.444	.097	.321	.233	.725	.434	.416	.919	.578	.493
.178	.245	.433	.486	.622	.175	.238	.108	.637	.215
.984	.396	.434	.416	.101	.104	.597	.875	.543	.576
.574	.639	.116	.101	.754	.982	.358	.444	.856	.269
.648	.264	.090	.088	.176	.867	.485	.794	.388	.790
.764	.412	.018	.018	.523	.060	.329	.655	.313	.135
.899	.070	.117	.270	.914	.048	.048	.584	.566	.209
.792	.356	.793	.143	.640	.582	.267	.216	.824	.437
.489	.886	.430	.327	.315	.988	.426	.805	.934	.717
.238	.089	.246	.485	.958	.600	.253	.142	.082	.320
.635	.122	.911	.217	.136	.907	.322	.090	.216	.392
.557	.997	.727	.181	.510	.704	.349	.505	.863	.872
.244	.180	.057	.721	.359	.643	.432	.780	.052	.125
.546	.478	.347	.550	.471	.608	.325	.426	.002	.398
.593	.238	.636	.852	.030	.196	.939	.804	.453	.222
.660	.685	.385	.749	.813	.926	.004	.225	.115	.425
.339	.388	.357	.853	.634	.170	.448	.564	.383	.310
.755	.918	.791	.359	.414	.149	.799	.173	.156	.482

.511	.455	.333	.085	.021	.048	.265	.797	.430	.371
.941	.656	.523	.385	.994	.813	.012	.823	.502	.839
.673	.721	.637	.123	.748	.661	.372	.018	.243	.837
.623	.125	.748	.141	.648	.765	.933	.514	.969	.321
.498	.162	.692	.878	.474	.159	.751	.130	.691	.831
.731	.909	.171	.055	.139	.911	.113	.100	.178	.526
.556	.031	.853	.660	.417	.154	.051	.984	.881	.607
.652	.347	.261	.626	.778	.667	.321	.987	.404	.102
.815	.058	.984	.893	.741	.420	.400	.853	.715	.406
.567	.607	.476	.847	.120	.358	.313	.226	.091	.065
.651	.121	.116	.531	.112	.952	.329	.659	.328	.426
.380	.119	.809	.074	.450	.294	.254	.992	.543	.468
.117	.790	.119	.214	.858	.563	.163	.630	.185	.112
.689	.342	.174	.450	.134	.503	.421	.835	.607	.458
.871	.947	.688	.521	.923	.904	.436	.405	.400	.370
.976	.402	.486	.070	.999	.912	.375	.307	.134	.183
.530	.153	.153	.665	.521	.673	.595	.136	.507	.350
.433	.142	.067	.485	.816	.919	.963	.090	.751	.109
.247	.575	.220	.881	.124	.531	.012	.304	.165	.532
.985	.274	.841	.514	.476	.054	.371	.445	.131	.143
.153	.225	.585	.818	.598	.942	.333	.875	.250	.343
.091	.363	.923	.765	.005	.723	.899	.040	.114	.329
.491	.031	.258	.483	.518	.486	.840	.473	.544	.420
.231	.641	.742	.545	.179	.239	.142	.285	.170	.939
.931	.282	.138	.982	.406	.460	.059	.632	.239	.478
.587	.524	.683	.925	.145	.942	.385	.789	.371	.284
.580	.031	.961	.573	.009	.041	.992	.477	.556	.334
.334	.334	.106	.583	.892	.252	.111	.046	.604	.406
.967	.493	.221	.596	.314	.105	.328	.298	.385	.056
.367	.069	.941	.022	.162	.689	.959	.192	.896	.887
.980	.035	.631	.863	.234	.175	.946	.286	.678	.269
.673	.050	.559	.199	.416	.973	.543	.284	.157	.683
.356	.760	.248	.205	.054	.122	.160	.689	.197	.248
.578	.991	.208	.348	.259	.215	.946	.718	.795	.626
.589	.082	.788	.836	.125	.718	.733	.158	.493	.834
.358	.241	.973	.766	.790	.027	.703	.111	.136	.417
.369	.227	.963	.801	.718	.581	.254	.753	.451	.029
.379	.696	.880	.955	.858	.861	.443	.131	.858	.861
.327	.443	.131	.858	.619	.604	.277	.663	.156	.058
.567	.356	.247	.001	.124	.458	.646	.894	.576	.893

APPENDIX B: LS-100 METHOD FOR ROUNDING OFF OF DATA AND OTHER NUMBERS

1. SCOPE

1.1 This method describes the procedure to be used for the rounding-off of all numbers.

2. GENERAL

Test values and calculated values are to be rounded in accordance with the criteria prescribed in Section 3.0.

3. CRITERIA

3.1 When the digit beyond the last place to be retained is less than 5, then the digit in the last place retained will remain (see Examples 1 & 2).

3.2 When the digit beyond the last place to be retained is greater than or equal to 5, then the digit in the last place to be retained will be increased by 1 (see Examples 1 & 2).

3.3 When a number is to be rounded, it will be rounded in one step only to the precision required and not rounded in two or more consecutive steps. For example: the number 1.347 can be rounded to 1.35 (to two decimal places). However, it is not acceptable to subsequently take 1.35 and then round it to the value of 1.4 to obtain a precision to one decimal place. In the method described herein, 1.347, rounded to one decimal place would have a value of 1.3.

NOTE 1: The requirement of rounding in one step does not refer to a rounded result which may have been obtained from a formula that may itself consist of rounded numbers. For example, it is perfectly acceptable to use % passing results which are themselves rounded to produce a rounded fineness modulus.

3.4 If, in special cases, it is desired to round off a number to the nearest 5, 0.5,0.05, 0.005 etc., then the observed or calculated value (with any number of significant digits) will be doubled, then respectively rounded to the nearest 10, 1, 0.1, 0.01 etc., in accordance with 3.1 to 3.3. The rounded result will then be divided by 2 (see Example 3).

Examples:

Example #1
Rounding to the closest whole number:

4.49	= 4	7.49	= 7
4.50	= 5	7.50	= 8
4.5	= 5	7.5	= 8
4.51	= 5	7.51	= 8

Example #2
Rounding to the closest 0.1:

7.649	=7.6	7.349	=7.3
7.650	=7.7	7.350	=7.4
7.65	=7.7	7.35	=7.4
7.651	=7.7	7.351	=7.4

Example #3
Rounding to the closest 0.05:

1.1249	x 2 = 2.2498	: 2.2 / 2 = 1.10
1.1250	x 2 = 2.2500	: 2.3 / 2 = 1.15
1.125	x 2 = 2.250	: 2.3 / 2 = 1.15
1.126	x 2 = 2.252	: 2.3 / 2 = 1.15

APPENDIX C: LS-101 METHOD FOR CALCULATION OF PERCENT WITHIN LIMITS

1. SCOPE

1.1 This method describes the procedure to be used for calculation of Per cent Within Limits**.**

2. RELEVANT DOCUMENTS

2.1 MTO Test Methods LS-100

3. DEFINITIONS

3.1 Per cent Within Limits (PWL) is an estimate of the percentage of the population (lot) that is within specification limits, determined by using the mean and standard deviation of the lot.

3.2 Mean ($\overline{X}$) is the arithmetic average of a set of test results.

3.3 Lot Standard Deviation (s) is the square root of the value found by summing the squares of the difference between each test result and the mean of the test results divided by the number of test results minus one (n-1).

3.4 Quality Index (Q_i) is a statistic which, when used with appropriate tables, provides an estimate of PWL of a lot. It can be based on an Upper or Lower Specification Limit, yielding Q_U or Q_L respectively.

4. GENERAL

4.1 All test results for a lot will be combined to calculate the Mean and Standard Deviation of the lot which will then be used to determine the Per cent Within Limits (PWL), according to the procedures in Section 5.

4.2 Any necessary rounding-off of test results or calculations will be in accordance with LS-100.

4.3 The lot mean will be reported to one decimal place. The Lot Standard Deviation, Lower Quality Index, and Upper Quality Index will be reported to two decimal places.

5. CALCULATIONS

5.1 The Quality Index, $Q_{i,}$ for the lower and upper specification limits shall be as determined from the following formulae:

$$Q_L = \frac{\overline{X} - LL}{s} \qquad Q_U = \frac{UL - \overline{X}}{s}$$

where:

Q_L	=	Lower Quality Index Value
Q_U	=	Upper Quality Index Value
LL	=	Lower Specification Limit
UL	=	Upper Specification Limit
$\overline{X}$	=	lot mean
s	=	lot standard deviation

5.2 PWL shall be determined from the following formula: $PWL = (P_L + P_U) - 100$

where: PWL = Per cent Within Limits
P_L = Per cent Within Lower Limit
P_U = Per cent Within Upper Limit

P_L and P_U are each determined from Table 1 based on Q_L and Q_U and the number of test results (n).

Where a lower limit is not specified, P_L will be 100. Where an upper limit is 100% or is not specified, P_U will be 100.

5.3 Notes for Table 1:

1. Enter the table using the number of test results and Q value.

2. If the value of Q_L or Q_U does not correspond exactly to a value in Table 1, use the next highest value of Q_L or Q_U from the table. The maximum P_L or P_U is 100.

3. Move across the table horizontally from the appropriate Q value to get P_L or P_U.

4. For negative values of Q_L or Q_U, enter the table using the absolute value of Q. P_L or P_U is equal to 100 minus the value from Table 1 for P_L or P_U.

6. EXAMPLES

6.1 Mean ($\overline{X}$) = 35.4 Lower Specification Limit (LL) = 30
Standard Deviation (s) = 3.22 Number of Test Results (n) = 42

$$Q_L = \frac{\overline{X} - LL}{s} = \frac{35.4 - 30}{3.22}$$

$$Q_L = 1.68$$

Look in Table 1 under $n = 42$ (see column $n = 38$ to $n = 69$).

As $Q_L = 1.68$ does not correspond exactly to a value in the table, use the next highest value in the column, 1.73.

Look across the table to the corresponding value of $P_L = 96$.

$P_U = 100$ (no upper limit is specified).

$$PWL = (P_L + P_U) - 100$$
$$= (96 + 100) - 100$$
$$= 96$$

6.2 Mean ($\overline{X}$) = 95.3
Standard Deviation (s) = 2.87
Number of Test Results (n) = 12

Lower Specification Limit (LL) = 91.5
Upper Specification Limit (UL) = 97.0

$$Q_L = \frac{\overline{X} - LL}{s} = \frac{95.3 - 91.5}{2.87}$$

$$Q_U = \frac{UL - \overline{X}}{s} = \frac{97.0 - 95.3}{2.87}$$

$Q_L = 1.32$

$Q_U = 0.59$

From Table 1: $P_L = 91$
$P_U = 72$

$$PWL = (P_L + P_U) - 100$$
$$= (91 + 72) - 100$$
$$= 63$$

6.3 Mean ($\overline{X}$) = 222.4
Standard Deviation (s) = 8.72

Upper Specification Limit (UL) = 220
Number of Test Results (n) = 61

$$Q_U = \frac{UL - \overline{X}}{s} = \frac{220 - 222.4}{8.72}$$

$Q_U = -0.28$

From Table 1, a Q_i of 0.28 gives a P_i of 61, however, as Q_U is negative.

$P_U = 100 - 61 = 39$

P_L = 100 (no lower limit is specified)

$$PWL = (P_L + P_U) - 100$$
$$= (100 + 39) - 100$$
$$= 39$$

TABLE 1: Values for P_L and P_U for a Given Quality Index and Number of Tests

P_L or P_U	Quality Index (Q_L or Q_U)														
	n=3	n=4	n=5	n=6	n=7	n=8	n=9	n=10 to n=11	n=12 to n=14	n=15 to n=18	n=19 to n=25	n=26 to n=37	n=38 to n=69	n=70 to n=200	n>200
100	1.16	1.50	1.79	2.03	2.23	2.39	2.53	2.65	2.83	3.03	3.20	3.38	3.54	3.70	3.83
99	1.16	1.47	1.67	1.80	1.89	1.95	2.00	2.04	2.09	2.14	2.18	2.22	2.26	2.29	2.31
98	1.15	1.44	1.60	1.70	1.76	1.81	1.84	1.86	1.91	1.93	1.96	1.99	2.01	2.03	2.05
97	1.15	1.41	1.54	1.62	1.67	1.70	1.72	1.74	1.77	1.79	1.81	1.83	1.85	1.86	1.87
96	1.14	1.38	1.49	1.55	1.59	1.61	1.63	1.65	1.67	1.68	1.70	1.71	1.73	1.74	1.75
95	1.14	1.35	1.44	1.49	1.52	1.54	1.55	1.56	1.58	1.59	1.61	1.62	1.63	1.63	1.64
94	1.13	1.32	1.39	1.43	1.46	1.47	1.48	1.49	1.50	1.51	1.52	1.53	1.54	1.55	1.55
93	1.13	1.29	1.35	1.38	1.40	1.41	1.42	1.43	1.44	1.44	1.45	1.46	1.46	1.47	1.47
92	1.12	1.26	1.31	1.33	1.35	1.36	1.36	1.37	1.37	1.38	1.39	1.39	1.40	1.40	1.40
91	1.11	1.23	1.27	1.29	1.30	1.30	1.31	1.31	1.32	1.32	1.33	1.33	1.33	1.34	1.34
90	1.10	1.20	1.23	1.24	1.25	1.25	1.26	1.26	1.26	1.27	1.27	1.27	1.28	1.28	1.28
89	1.09	1.17	1.19	1.20	1.20	1.21	1.21	1.21	1.21	1.22	1.22	1.22	1.22	1.22	1.23
88	1.07	1.14	1.15	1.16	1.16	1.16	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17
87	1.06	1.11	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.13
86	1.04	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08
85	1.03	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
84	1.01	1.02	1.01	1.01	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.99
83	1.00	0.99	0.98	0.97	0.97	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.95	0.95	0.95
82	0.97	0.96	0.95	0.94	0.93	0.93	0.93	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
81	0.96	0.93	0.91	0.90	0.89	0.89	0.89	0.89	0.89	0.88	0.88	0.88	0.88	0.88	0.88
80	0.93	0.90	0.88	0.87	0.86	0.86	0.86	0.85	0.85	0.85	0.85	0.84	0.84	0.84	0.84
79	0.91	0.87	0.85	0.84	0.83	0.82	0.82	0.82	0.82	0.81	0.81	0.81	0.81	0.81	0.81
78	0.89	0.84	0.82	0.80	0.80	0.79	0.79	0.79	0.78	0.78	0.78	0.78	0.77	0.77	0.77
77	0.87	0.81	0.78	0.77	0.76	0.76	0.76	0.75	0.75	0.75	0.75	0.74	0.74	0.74	0.74
76	0.84	0.78	0.75	0.74	0.73	0.73	0.72	0.72	0.72	0.71	0.71	0.71	0.71	0.71	0.71
75	0.82	0.75	0.72	0.71	0.70	0.70	0.69	0.69	0.69	0.68	0.68	0.68	0.68	0.68	0.67
74	0.79	0.72	0.69	0.68	0.67	0.66	0.66	0.66	0.66	0.65	0.65	0.65	0.65	0.64	0.64
73	0.76	0.69	0.66	0.65	0.64	0.63	0.63	0.63	0.62	0.62	0.62	0.62	0.62	0.61	0.61
72	0.74	0.66	0.63	0.62	0.61	0.60	0.60	0.60	0.59	0.59	0.59	0.59	0.59	0.58	0.58
71	0.71	0.63	0.60	0.59	0.58	0.57	0.57	0.57	0.57	0.56	0.56	0.56	0.56	0.55	0.55
70	0.68	0.60	0.57	0.56	0.55	0.55	0.54	0.54	0.54	0.53	0.53	0.53	0.53	0.53	0.52
69	0.65	0.57	0.54	0.53	0.52	0.52	0.51	0.51	0.51	0.50	0.50	0.50	0.50	0.50	0.50
68	0.62	0.54	0.51	0.50	0.49	0.49	0.48	0.48	0.48	0.48	0.47	0.47	0.47	0.47	0.47
67	0.59	0.51	0.47	0.47	0.46	0.46	0.46	0.45	0.45	0.45	0.45	0.44	0.44	0.44	0.44
66	0.56	0.48	0.45	0.44	0.44	0.43	0.43	0.43	0.42	0.42	0.42	0.42	0.41	0.41	0.41
65	0.52	0.45	0.43	0.41	0.41	0.40	0.40	0.40	0.40	0.39	0.39	0.39	0.39	0.39	0.39
64	0.49	0.42	0.40	0.39	0.38	0.38	0.37	0.37	0.37	0.37	0.36	0.36	0.36	0.36	0.36
63	0.46	0.39	0.37	0.36	0.35	0.35	0.35	0.34	0.34	0.34	0.34	0.34	0.33	0.33	0.33
62	0.43	0.36	0.34	0.33	0.32	0.32	0.32	0.32	0.31	0.31	0.31	0.31	0.31	0.31	0.31
61	0.39	0.33	0.31	0.30	0.30	0.29	0.29	0.29	0.29	0.29	0.28	0.28	0.28	0.28	0.28
60	0.36	0.30	0.28	0.27	0.27	0.27	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.25	0.25
59	0.32	0.27	0.25	0.25	0.24	0.24	0.24	0.24	0.23	0.23	0.23	0.23	0.23	0.23	0.23
58	0.29	0.24	0.23	0.22	0.21	0.21	0.21	0.21	0.21	0.21	0.20	0.20	0.20	0.20	0.20
57	0.25	0.21	0.20	0.19	0.19	0.19	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18
56	0.22	0.18	0.17	0.16	0.16	0.16	0.16	0.16	0.16	0.15	0.15	0.15	0.15	0.15	0.15
55	0.18	0.15	0.14	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13
54	0.14	0.12	0.11	0.11	0.11	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
53	0.11	0.09	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
52	0.07	0.06	0.06	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
51	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.02
50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

APPENDIX D: PROVAL USER'S GUIDE FOR INERTIAL PROFILERS

ProVAL 3.4 / 3.5 User's Guide

Prepared by MTO Bituminous Section – **March 2016**

A. General

1) **ProVAL 3.4 and 3.5 are equivalent, however, ProVAL 3.5 has built in mapping capabilities.**
2) Double-Left click on **ProVAL 3.4 or 3.5** and open it.
3) ProVAL looks for files from a folder specified by the user. To change the folder path left-click the **Options** icon in the **Tools** task bar then browse for/type in the new folder path in the **Default Project Path** section under general settings.
4) In **Options** the user can also select/de-select **SI Units, Enable Recording Log, and other options.** The user can also **change the language for the program**, **change the default file format** and **provide a path to a spreadsheet program** so that ProVAL can import analyses results into a spreadsheet format. The user should provide the path to Microsoft Excel execution file (EXCEL.EXE). To do this simply go to **Start → Search → Type excel.exe in search**, then once the path is found copy the path to ProVAL in **Options**.
5) In **Options** the user can set the **Default Analysis** as well as select or de-select any of the analyses that are shown in the **Analysis** tab. Make sure that at least ***Automated Filtering, Power Spectral Density, Profiler Certification, Ride Quality*** and ***Smoothness Assurance*** are all checked.
6) If you change anything, left click on **OK.** Otherwise, just left click on **Cancel.**
7) To begin analyzing a new file, continue analyzing a file or update the program software, apply the following steps after opening the program:

   (i) The program's initial screen will show the **Getting Started** & **Tools task bars** in the top left corner. Left click the **New** icon in the task bar to create a new file.
   (ii) **For access to program support**, the ProVAL 3.4**/3.5** complete user guide and save logs, left click the **Help** icon on the **"Tools"** task bar.
   (iii) Below the task bars in the top left corner is a list of **Recent Projects**. These are projects that the user has previously opened; **to continue working on a file** in this list, simply left click the file link in this list.
   (iv) ProVAL 3.4**/3.5** automatically saves temporary copies of a file during the time that a user is working on it. Should the program or the user's computer crash before the user can save the file; the user can access the temporary saved copy of the file. After opening the program and getting to the initial screen left click the link to the temporary file under **Unsaved Projects,** which is located in the bottom left corner of the initial screen.
   (v) To update the ProVAL program, click on the latest program release links in the **ProVAL Online** section of the initial screen.
   (vi) To **open** .erd files, double click the file within the folder; do not try to open the file from the open menu of ProVAL 3.4**/3.5**.
   (vii) To **open** .adf files, left click and drag the file from the folder into the ProVAL 3.**4/3.5** screen. Note: .adf files will not open by double clicking the files in the folder and the open menu of ProVAL.

8) Left Click on box for ***LElev, RElev*** and/or ***both;*** clicking ***LElev*** shows the left profile, clicking ***RElev*** shows the right profile and clicking both shows both profile simultaneously.
9) Move the cursor to somewhere in the profile and then left click and drag to create a box; then let go. This is the zooming function. Left click on ***back arrow*** to zoom back to full profile view or undo a particular zoom; the ***back & forward arrows*** can be found underneath the task bar at the top of the screen and to the right of the ***LElev/RElev*** boxes.

10) In the **Display** task bar (at the top of the screen) the user can select the units that the ***LElev*** and ***RElev*** profiles are plotted in. Since metric units are typically used, the user should set the plot units to ***M/MM*** (defines distance in meters on the x-axis and elevation in millimetres on the y-axis).
11) Go to ***File*** **drop-down menu** to view the original as well as the filtered files.

B. Editing Tools

1) While in Editor, left click on the drop-down box labelled ***Navigate*** again; choose ***Basic*****.**

Lead-in & Lead-out (works for ***Profiler Certification***)

2) Change the **Lead-In** to ***100*** **m** and left click on **Save.** Note the event marker, the gray shaded area, covers the beginning of the profile to 100 m into the profile. The **Lead-In** defines the lead-in distance to the analysis' start location (from the profile's beginning location).
3) Now change the **Lead-Out** to ***400*** **m** and left click on **Save** (another gray shaded area will be created). The **Lead-Out** defines the lead-out distance from the profile's end location. Moving the cursor anywhere on the profile gives a view of elevation and distance information in the top right corner underneath the ***Navigate*** drop-down menu.
4) When you are actually doing the measurements you may be required to have lead-in and lead-outs of at least 100 m.

Other Editing Features in *Basic* (works for ***Profiler Certification, Ride Quality, Rolling Straightedge and Smoothness Assurance)***

Profile Direction

5) The ***Profile Direction*** establishes the direction regarding the distance reference system. To analyse the profile from the initial data point to the end point, choose the ***Forward*** direction in the ***Profile Direction*** drop-down menu. To analyse the profile from the end point to the initial data point, choose the ***Reverse*** direction.

Distance Offset

6) The ***Distance Offset*** determines the offset to the start location (i.e. the zero distance reference). Type in the distance offset and left-click **Save**.

Sample Interval

7) The ***Sample Interval*** defines the distance set between stored sampling points (in millimetres). Change the interval value as desired and left-click **Save**.

Geography

8) The GPS coordinates can be entered into the boxes for ***Longitude*** and ***Latitude.*** Enter the format in degrees (dd.dddd) ensuring that latitude is inputted as –dd.dddd, then left-click **Save.** By returning to ***Viewer*** left-click on the profile and select **Show on Map** to automatically open the internet browser and show the profile on Google Maps.

Defining Sections

9) While in Editor, left click on the drop-down box labelled ***Navigate*** and choose ***Sections*****.**

10) In this window, you can define as many sections as you need (e.g., exempt areas, sublots with lengths different than 100 m, etc.). This is done by left clicking the double sided arrow with the plus sign underneath the editor toolbar. After clicking, ProVAL will prompt to enter a name. After naming, a start and stop distance can be entered. Also, the type drop down menu consists of leave-out, which does not include the area in calculations (exempted areas).

C. Ride Quality (IRI) Analysis

The ***Ride Quality*** feature gives three types of ride statistics analyses:

(i) ***Overall*** – for reporting over the entire profile,
(ii) ***Fixed Interval*** – for reporting at fixed intervals set by the user,
(iii) ***Continuous*** – reporting at every sample interval.

The ***Ride Quality*** replaces the ***Rides Stats at Interval*** feature in **ProVAL 2.7.**

1) Go to **Analysis** at the top of the screen and pick ***Ride Quality*** from the dropdown menu.
2) Choose **Fixed Interval (**in the **Inputs** section).
3) Beside **Ride Quality Index**, choose **IRI** from the drop-down menu.
4) Choose a file to do a ride statistical analysis on by selecting the appropriate **LElev/RElev** boxes in the **Profile** section. If no file is selected, the **Validation** drop-down box will become active; upon left-clicking this box, ProVAL will tell the user "***at least one profile must be selected"***. This ***Profile Selection*** feature replaces the ***"Point Reset"*** feature in the ***ProVAL 2.7.***
5) Choose a section that you need to analyze. The drop down menu will display all the sections that you have defined using the Editor.
6) **Select Apply 250 mm filter**.
7) Change the **Threshold** to (say) ***1.25 m/km***.
8) Change the **Baselength** to ***100.0 m*** (or any other number if the sublot length is different than 100 m).
9) Left click on **Analyze** – ProVAL gives you the option to view the data as a chart or a graph. Each shows IRI values for both left and right wheelpaths within 100 m sublots.
10) ProVAL will display **IRI** profile graphs for both the **RElev** and **LElev**, however, the histograms on the screen entitled Profile can only display one wheel path at a time. To switch between **RElev** and **LElev** select either one in the drop-down menu above the histograms.

D. Smoothness Assurance Module

The ***Smoothness Assurance Module (SAM)*** has replaced ***Localized Roughness*** in ProVAL 2.7. This module can be used to produce ***ride quality reports*** and ***optimize grinding strategies*** by analyzing measurements from profiles collected using inertial profilers. The module also gives users the option of defining grinding strategies within it; the module can also generate comprehensive reports that include ride quality reports before and after grinding.

1) Go to the **Analysis** drop-down menu at the top of the screen, and pick ***Smoothness Assurance***.
2) Beside **Ride Quality Index** choose **MRI (Mean of left and right IRIs).** Under the Ride Quality Index **threshold** and **baselength** inputs can be changed as required for Short Continuous, Long Continuous and Fixed Interval analyses. For **Short Continuous** Analysis, set the length and threshold inputs to ***7.62 m*** and ***2.4 m/km,*** respectively. This function will generate a roughness report that is equivalent to **localized roughness.** However, the unit is in m/km.
3) Select the appropriate file and ensure to ***Apply 250mm filter***. The ***Comparison*** type can be left as **None**.

4) Left click **Analyze** in the top right corner. Now left click the **Navigate** dropdown menu and select **Short Continuous.** The IRI analyses results for the profile indicating localized roughness locations (with MRIs larger than 2.4 m/km) can now be seen.

Grinding

5) To apply a **Grinding** analysis to the data in comparison with the **Short Continuous** analysis, go to the **Navigate** drop-down menu and select **Grinding.** The **Grinder** type can be customized or the user can select from an 18, 25, or customize your own foot wheelbase. The **Short Cutoff Wavelength** must be ***0.250 m.*** All other grinding criteria input values can be specified by the user.
6) Left click the **Grind** option in the top right corner (to the left of the **Navigate** drop-down menu); then left click the **Navigate** drop-down menu and select **Short Continuous** again. The IRI analyses results for the profile indicating localized roughness locations and magnitudes can now be seen **before and after** the grinding analysis has been conducted.

E. Report

1) A report can be generated by left clicking on **Report** icon in the top left corner of the program screen, in the **Project** task bar. Select a file format for the ProVAL report. The user can choose from the following formats:
   - **PDF file (.pdf)** – ProVAL will automatically generate a PDF report if this option is chosen.
   - **Excel spreadsheet (.xls)** – ProVAL will prompt the user to select a computer folder for the file and then saves the report in that folder. To access the report, locate the specified folder and then open the report.
   - **Text file (.txt)** – ProVAL will prompt the user to select a computer folder to create for the file and then saves the report in that folder. To access the report, locate the specified folder and then open the report.
2) You can use the excel file to transfer the data into MTO smoothness spreadsheet.

F. Profiler Certification Analysis (used for Profiler Correlation)

1) First **open all 6 files** (5 runs from inertial profiler and 1 run from a reference device) for correlation.
2) Go to the **Analysis** drop-down menu at the top of the screen and pick ***Profiler Certification***.
3) The **Maximum Offset** should be ***1.52***.
4) Change **Repeatability Passing Score** to ***92.***
5) Change **Accuracy Passing Score** to ***90.***
6) Select all six files and select the reference device as the basis.
7) Under **Basis Filter** and **Comparison Filter** ensure to select **IRI (with 250mm Filter).**
8) Left click **Analyze** and wait for the results to appear.
9) There will be separate tables for Repeatability and Accuracy for each of the left and right sensors indicating whether a sensor has passed or failed.

G. Power Spectral Density Analysis

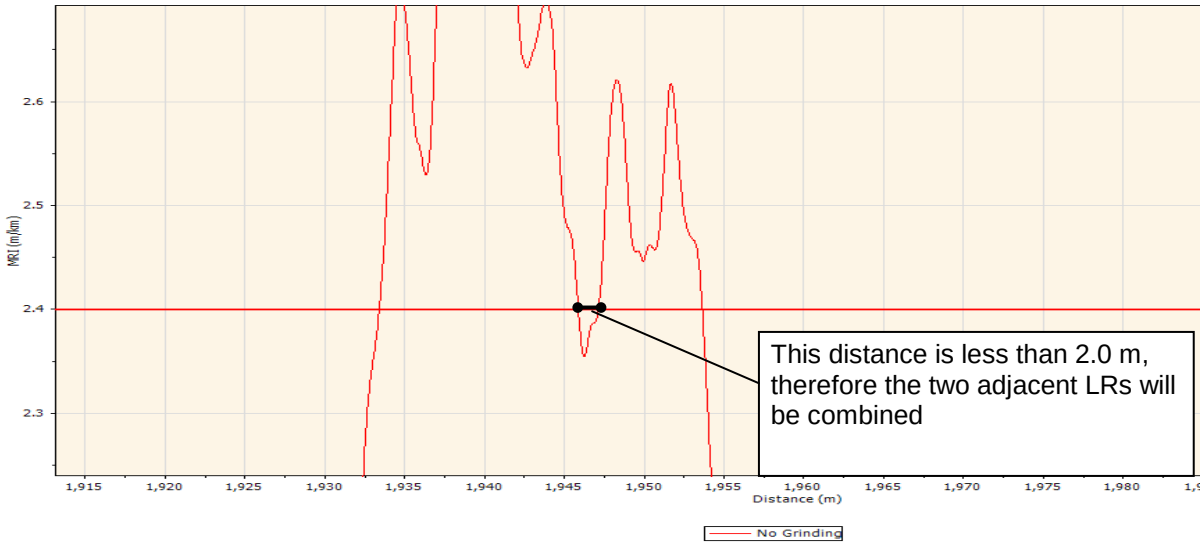
1) Go to **Analysis** at the top of the screen and pick ***Power Spectral Density*** from the drop-down menu.
2) Left click the ***LElev*** for first file. This was the unfiltered file.
3) Set the **Filter Type** to ***None.***
4) Make sure that **Octave Bands** is checked and **Bands per Octave** is set at 12.

5) Left click on **Analyze.**
6) Under **Navigate**, go to **Elevation PSD (Wave Length).**
7) This shows the breakdown of the various wavelengths that make up the profile. Notice that it's a fairly straight line. You can use this analysis to look at a file and see how removing wavelengths affects a profile. However, even a so-called "raw" data file always has some filtering. But, if you understand this well, you may be able to determine how much it has been pre-filtered. In any case, the waves that most affect IRI are the ones between 1 and 30 m.

Guidelines for Populating MTO's Smoothness Excel Spreadsheet for Localized Roughness (LR)

Prepared by MTO Bituminous Section – April 2012

1. After analyzed raw data files in ProVAL, use ProVAL reports to populate MTO's Smoothness Excel Spreadsheet.
2. A Localized Roughness (LR) must be detected in at least two runs (out of 3 runs) to be considered a valid LR and be given a Category (either Pay adjustment or Rejectable).
3. The combined LR limits will be the average start station and average stop station of the three runs (or two runs if the LR has been detected by two runs only). Combined MRI will be the average MRI of the three runs (or two runs if the LR has been detected by two runs only).
4. For every given run, if two or more LRs are in close proximity of each other so that the end point of one LR is less than 2.0 m apart from the start point of the next one, like the example below, then the LRs will be combined as explained below.



Original ProVAL report for the above two LRs will be as follows:

ProVAL Report

Start Station			Stop Station			MRI (m/km)
1	+	933.4	1	+	945.9	3.23
1	+	947.2	1	+	953.7	2.62

1947.2 – 1945.9 < 2.0 m

In the above entry, the first LR's stop station (1+945.9) is less than 2.0 meters away from the second LR's start station (1+947.2) and they are both in the same run. When this happens, the two LRs will have to be combined and reported as one LR. Take the first LR's start station, the second LR's stop station, and the higher MRI and input into MTO's Excel spreadsheet.

Data entry into MTO smoothness Excel spreadsheet for the above example should be as follows:

MTO Smoothness Excel Spreadsheet

Start Station			Stop Station			MRI (m/km)
1	+	933.4	1	+	953.7	3.23

5. In the ProVAL report below, Run 1 has two LRs that are within the station limits of one LR in the other two runs. When this happens the LR in Run 1 with the longer overlap with the LRs in Runs 2 and 3 are placed in the same row. The other LR in Run 1 gets its own row.

ProVAL Report

Run 1							Run 2							Run 3						
Start Station			Stop Station			MRI (m/km)	Start Station			Stop Station			MRI (m/km)	Start Station			Stop Station			MRI (m/km)
0	+	99.1	0	+	102.9	3.17	0	+	98.9	0	+	115.6	4.54	0	+	99.0	0	+	115.7	4.45
0	+	106.3	0	+	115.4	4.14		+			+				+			+		

Therefore, the data entry into MTO Smoothness Excel Spreadsheet should look like the following:

MTO Smoothness Excel Spreadsheet

Run 1								Run 2								Run 3								Combined							
Start Station[1,2]			Stop Station[1,2]			MRI[3] (m/km)		Start Station[1,2]			Stop Station[1,2]			MRI[3] (m/km)		Start Station[1,2]			Stop Station[1,2]			MRI[3] (m/km)		Start Station[1,2]			Stop Station[1,2]			MRI[3] (m/km)	Localized Roughness Category
0	+	99.1	0	+	102.9	3.17			+			+					+			+					+			+				
0	+	106.3	0	+	115.4	4.14		0	+	98.9	0	+	115.6	4.54		0	+	99.0	0	+	115.7	4.45		0	+	101.40	0	+	115.57	4.38	Rejectable

6. In the ProVAL report below, Run 1 and Run 2 have two LRs that are within the station limits of one LR in Run 3. When this happens, the LRs in Run 1 and 2 with the longer overlap with the LR in Run 3 are placed in the same row. The other LRs in Runs 1 and 2 get their own row and are recorded as another LR since two runs have recorded the LR.

ProVAL Report

Run 1							Run 2							Run 3						
Start Station			Stop Station			MRI (m/km)	Start Station			Stop Station			MRI (m/km)	Start Station			Stop Station			MRI (m/km)
0	+	99.1	0	+	102.9	3.17	0	+	98.9	0	+	102.9	3.17	0	+	99.0	0	+	115.7	4.45
0	+	106.3	0	+	115.4	4.14	0	+	105.8	0	+	115.5	4.18		+			+		

Therefore, the data entry into MTO Smoothness Excel Spreadsheet should look like the following:

MTO Smoothness Excel Spreadsheet

Run 1							Run 2							Run 3							Combined							
Start Station[1,2]			Stop Station[1,2]			MRI[3] (m/km)	Start Station[1,2]			Stop Station[1,2]			MRI[3] (m/km)	Start Station[1,2]			Stop Station[1,2]			MRI[3] (m/km)	Start Station[1,2]			Stop Station[1,2]			MRI[3] (m/km)	Localized Roughness Category
0	+	99.1	0	+	102.9	3.17	0	+	98.9	0	+	102.9	3.17		+			+			0	+	99.00	0	+	102.90	3.17	**Pay Adjustment**
0	+	106.3	0	+	115.4	4.14	0	+	105.8	0	+	115.5	4.18	0	+	99.0	0	+	115.7	4.45	0	+	103.70	0	+	115.53	4.26	**Rejectable**

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