

FIELD GUIDE

FOR THE ACCEPTANCE OF HOT MIX ASPHALT AND BRIDGE DECK WATERPROOFING



Prepared by:
Bituminous Section
Materials Engineering and Research Office
Ontario Ministry of Transportation

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To all users of the: **FIELD GUIDE FOR THE ACCEPTANCE OF HOT MIX ASPHALT AND BRIDGE DECK WATERPROOFING, JULY 2017**

Enquiries regarding amendments, suggestions, or comments should be directed to:

Bituminous Section

Materials Engineering and Research Office

Ontario Ministry of Transportation

145 Sir William Hearst Avenue, Room 238

Downsview, Ontario

M3M 0B6

416 – 235 – 3715

bituminous@ontario.ca

TABLE OF CONTENTS

PREFACE	V
MAJOR CHANGES SINCE THE 2016 FIELD GUIDE	VI
2016-2017 INITIATIVES	VIII
1 SUBMISSIONS	1
1-1 General	1
1-1.1 Warm Mix Asphalt	1
1-2 Prior to the Start of Paving	1
1-2.1 Contractor Mix Design (1151)	2
1-2.1.1 Percent Reclaimed Asphalt Pavement / Roof Shingle Tabs (F06)	3
1-2.2 Prior to Use of HMA Aggregates (S12, 1001, & 1151)	4
1-2.3 Prior to Use of Coated Gritting Materials for SMA (NSSP)	4
1-2.4 Prior to Use of PGAC (F03, 1101 & F09)	4
1-2.4.1 Prior to Use of PGAC with Asphalt Cement Anti-Stripping Treatment (1151)	5
1-2.5 Prior to Use of Tack Coat (308)	5
1-2.5.1 Prior to Use of an Alternative Tack Coat Product (308)	5
1-2.6 Prior to Paving on Bridge Decks (F03)	5
1-3 Field Adjustments to the Job Mix Formula (F03)	6
1-4 Calcium Chloride	6
1-5 Before the End of each Calendar Year	6
2 SAMPLING HOT MIX ASPHALT MATERIALS	9
2-1 General	9
2-2 Sampling for Density Testing of HMA Aggregates and Calculating VMA (F03)	10
2-2.1 Sampling for Density Testing of HMA Aggregates (F03)	10
2-2.2 Calculating VMA (F03)	10
2-3 Sampling for HMA Aggregates (S12)	10
2-3.1 Sample Size (S12)	10
2-3.2 Sampling Frequency (S12)	11
2-4 Sampling for Mix and Volumetric Properties (F03)	11
2-4.1 Sample Size (F03)	11
2-4.2 Sampling Frequency (F03)	12
2-4.2.1 Sampling Frequency for Square Metre Items (F03)	12
2-4.3 Sampling Methods and Random Sample Locations	13
2-4.3.1 Quantity Method for Loose Mix Samples (F03)	14
2-4.3.2 Random Sample Locations for Square Metre Items (F03)	16
2-5 Core Sampling for Compaction Testing and Sampling of the Release Agent (F03)	17
2-6 Core Sampling for Lift Thickness (F03)	20
2-6.1 Sample Size (F03)	20
2-6.2 Sampling Frequency (F03)	20
2-6.3 Sampling Method and Random Sample Locations (F03)	21
2-7 Sampling for SMA Coated Gritting Materials (NSSP)	23
2-7.1 Sample Size (NSSP)	23
2-7.2 Sampling Frequency (NSSP)	23
2-8 Sampling for PGAC (1101 & F09)	24
2-9 Guidance on Setting up Lots and Sublots (F03)	25

2-9.1	Paving on Bridge Decks and Staged Construction - All Item Quantities (F03)	26
2-9.1.1	Bridge Decks and Construction Stages Greater than 100 Tonnes (F03)	26
2-9.1.2	Bridge Decks and Construction Stages Less than 100 Tonnes (F03)	26
2-9.2	Item Quantity Greater than 5,000 Tonnes (F03)	27
2-9.3	Item Quantity 1,000 Tonnes to 5,000 Tonnes (F03)	30
2-9.4	Item Quantity Less than 1,000 Tonnes (F03)	31
2-9.5	Small Quantity Lots (Lots Comprised of 1 or 2 Sublots) (F03)	31
3	REPORTING HOT MIX ASPHALT TEST RESULTS	34
3-1	General (F03)	34
3-2	Conventions for Saving and Naming of Files	35
3-3	Reporting Mix Properties and Compaction (F03)	35
3-3.1	ERS - Hot Mix Asphalt Payment Calculation Spreadsheet (F03)	35
3-3.2	Using the Spreadsheet for Square Metre Items (F03)	38
3-4	Reporting Lift Thickness Test Results (F03)	38
3-4.1	ERS – Thickness Payment Adjustment Calculation Spreadsheet (F03)	38
3-5	Reporting PGAC Test Results	39
4	ACCEPTANCE OF HOT MIX ASPHALT BASED ON VISUAL OBSERVATION	44
4-1	General	44
4-2	Temperature (1151 & F03)	44
4-3	Acceptance of Surface Tolerance (F03)	45
4-4	Acceptance of Surface Appearance (F03)	45
4-4.1	Segregation (F03)	48
4-4.1.1	Initial Notification / Corrective Action for Segregation (F03)	48
4-4.1.2	Disposition of Segregated Mix (F03)	48
4-4.1.3	Continuing Segregation	49
4-4.1.4	Challenging the Severity of Segregation (F03)	49
4-5	Acceptance of Geometrics and Longitudinal Joint Location (F03)	51
4-5.1	Pavement Width (F03)	51
4-5.2	Longitudinal Joints (F03)	51
4-6	Repairs (F03)	52
4-7	Payment Issues (F03)	53
4-7.1	Payment for Repairs (F03)	53
4-7.2	Price Adjustments (F03)	53
5	ACCEPTANCE OF HOT MIX ASPHALT BASED ON TEST RESULTS	55
5-1	General	55
5-2	Acceptance based on Laboratory Test Results	55
5-2.1	Acceptance of HMA Aggregates (S12)	55
5-2.2	Acceptance of Mix Properties and Compaction (F03)	55
5-2.2.1	Additional Acceptance Requirements for SMA (F03)	56
5-2.2.2	Acceptance of Square Metre Items (F03)	57
5-2.3	Acceptance of Lift Thickness (F03)	57
5-2.4	Acceptance of PGAC (1101)	58
5-2.4.1	Additional Acceptance Requirements for PGAC (F09)	58
5-3	Referee Testing (F03)	59
5-3.1	General	59
5-3.2	Contract Administrator Referee Coordination Responsibilities	60
5-3.3	Referee for HMA Aggregates (S12)	61
5-3.4	Referee for Mix Properties and Compaction (F03)	61
5-3.5	Referee Testing for Lift Thickness (F03)	61
5-3.6	Referee Testing for PGAC (1101 & F09)	61

5-3.7	Outliers in Referee Results (F03)	61
5-3.8	Payment of Referee Testing Costs	64
5-4	Repairs	66
5-4.1	Repairs for Mix Properties and Compaction (F03)	66
5-4.2	Repairs for Lift Thickness (F03)	68
5-5	Example Calculations for PWL and Combined Payment Factors (F03)	68
5-6	Payment Adjustment for AC Content and Changes in the AC Price Index (F03)	74
5-6.1	HMA Quantity Calculation (F03)	75
5-6.2	Payment Adjustment for AC Content (F03)	75
5-6.3	Payment Adjustment for Changes in the AC Price Index (F03)	75
5-7	Payment Adjustment for HMA Aggregate Density (F03)	75
5-8	Payment for HMA Miscellaneous Items (F03)	76
6	ACCEPTANCE OF HOT MIX ASPHALT BASED ON SMOOTHNESS	78
6-1	General (F31)	78
6-2	Surface Tolerance (F03)	78
6-3	Correlation, Calibration, Approval, and Hiring of Profiler Operators (F31)	79
6-3.1	Correlation and Calibration (F31)	79
6-3.2	Approval of Profiler Operators (F31)	79
6-3.3	Hiring of Inertial Profiler for Acceptance Testing (F31)	79
6-4	Smoothness Correction of Pavement beneath Surface Courses (F03)	79
6-5	Measurement Frequency (F31)	81
6-5.1	Lot and Sublot Size (F31)	81
6-5.1.1	Additional Excluded Areas (F31)	82
6-5.1.2	Sublots at End-of-Lane (F31)	82
6-5.1.3	Sublots before Excluded Areas (F31)	83
6-5.1.4	Bridge Decks (F31)	83
6-5.2	Measurement of Surface Smoothness (F31)	84
6-5.2.1	Damage beyond the Contractor's Control (F31)	84
6-5.3	Referee Testing (F31)	85
6-6	Repairs and Redecisioning (F31)	85
6-7	Payment Issues (F31)	85
6-7.1	Localized Roughness (F31)	86
6-8	Responsibilities of the Contract Administrator (CAITM)	86
7	ACCEPTANCE OF HOT MIX ASPHALT BASED ON AREA IN SQUARE METRES	88
7-1	General (F03)	88
7-2	Sampling for Square Metre Items (F03)	88
7-2.1	Sampling for Lift Thickness (F03)	88
7-2.2	Sampling Mix Properties and Compaction for Square Metre Items (F03)	88
7-3	Acceptance of Square Metre Items (F03)	88
7-3.1	Acceptance of Lift Thickness (F03)	88
7-3.2	Acceptance of Mix Properties and Compaction for Square Metre Items (F03)	89
7-4	Referee Testing for Lift Thickness (F03)	89
7-5	Repairs for Lift Thickness (F03)	89
8	ACCEPTANCE OF TACK COAT	91
8-1	General (308)	91
8-2	Products (308)	91
8-3	Application (308 & 308F02)	91
8-4	Sampling of Tack Coat (308)	91
8-4.1	Extra Core Samples for Alternative Tack Coat	93
8-5	Acceptance of Tack Coat (308)	93

8-5.1	Acceptance of Tack Coat based on Visual Observation (308)	93
8-5.2	Acceptance of Tack Coat based on Test Results (308)	93
8-6	Referee Testing for Tack Coat (308)	94
8-7	Payment Adjustment for Tack Coat (308)	94
9	ACCEPTANCE OF BRIDGE DECK WATERPROOFING	96
9-1	General	96
9-2	Measurement of Protection Board Thickness	97
9-3	Sampling and Testing of Waterproofing Membrane Thickness	98
9-3.1	Waterproofing Membrane Thickness Acceptance Procedure	98
9-4	Sampling and Testing of Waterproofing Membrane Quality	106
9-4.1	Summary of Waterproofing Membrane Quality Acceptance Procedure	106
9-4.2	Payment Adjustment for Waterproofing Membrane Quality	107
9-4.3	Referee Testing for Waterproofing Membrane Quality	110
9-5	Treatment of Rejectable Lots of Waterproofing Membrane	112
	APPENDICES	114
	Appendix A: Random Number Table	A-1
	Appendix B: LS-100 Method for Rounding Off of Data and Other Numbers	B-1
	Appendix C: LS-101 Method for Calculation of Percent Within Limits	C-1
	Appendix D: ProVAL User's Guide for Inertial Profilers	D-1

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 103F03 **or a Special Provision that deletes and replaces OPSS 313 in 2017**. For Contracts with Special Provision 103F01, please refer to the **2016** "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 2016 Field Guide are shown in bold.

MAJOR CHANGES SINCE THE 2016 FIELD GUIDE

This section highlights some of the major changes that have been made since the **2016** Field Guide was published.

Chapter 1 - Submissions

- **Anti-Stripping Treatment (AST) terminology replaces Anti-Stripping Additives (ASA) terminology.**
- **Added guidance on waiving the compaction requirements for Superpave 9.5 used as padding to section 1-2.**
- **Added additional submission requirements for storing HMA in silos and release agents to section 1-2.**
- **The use of RAP and/or RST in the surface course is suspended where long lasting pavements are required and when RST is used in a binder course test results must be submitted with the mix design as detailed in section 1-2.1.1.**
- **Added additional PGAC documentation required to section 1-2.4.**
- **Added submission of compaction temperature prior to paving bridge decks requirement to section 1-2.6.**

Chapter 2 – Sampling Hot Mix Asphalt Materials

- **Samples taken for Superpave 12.5FC 1, Superpave 12.5FC 2, SMA 9.5 and SMA 12.5 Type (D) primary coarse aggregate are to be taken from separate sampling pads as per section 2-3.2.**
- **A 1 litre sample of release agent shall be delivered to the CA upon request.**
- **PGAC sample for possible Owner testing has been reduced to 2 L in section 2-8.**
- **A new CAITM Task BIT 21 has been added with sampling details.**

Chapter 3 – Reporting Hot Mix Asphalt Test Results

- **A General sheet and a Payment Adjustment sheet have been added to the “Hot Mix Asphalt Pay Factor Calculation” spreadsheet. The payment adjustments for aggregate density, asphalt cement content, PGAC price index, and segregation are now included. The final total payment adjustment is shown at the bottom of the General sheet.**

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

- **The temperature required prior to paving another lift or opening to traffic has been increased to 60°C in section 4-2.**
- **Added guidance on waiving the temperature requirements in consultation with the Regional Quality Assurance Section to section 4-2.**

Chapter 5 – Acceptance of Hot Mix Asphalt based on Test Results

- **Added example of Multiple Stress Creep Recovery (MSCR) test result categorization to section 5-2.4.1.**
- **Section 5-5 has been revised to include the new compaction lower limit, TODRF, and comparison to the past lower limit.**
- **Section 5-6.2 has been revised to use the ERS lot average Asphalt Cement (AC) content in place of the Job Mix Formula (JMF) AC content when calculating the payment adjustment for AC content.**

Chapter 6 – Acceptance of Hot Mix Asphalt based on Smoothness

- **Table 1B is added for IRI pay factor of pavements with one lift over CIR, FDR, CIREAM, and milled surfaces.**
- **Raised the bar to obtain incentives for smoothness based on IRI.**
- **Lowered the pay reductions based on Localized Roughness.**

Chapter 8 – Acceptance of Tack Coat

- **Section 8-2 revised to add that tack coat can now be SS-1 or SS-1HH.**

Chapter 9 – Acceptance of Bridge Deck Waterproofing

- **Additional sampling requirements of other materials added.**

2016-2017 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.

Changes to Hot Mix Asphalt

- **Special Provision 103F02 and OPSS.PROV 313 November 2016 includes the following changes:**
 - Definition for crack added, and cracking included under surface defects.
 - Documentation from hot mix producers regarding asphalt mix storage in silos has been added,
 - Temperature restriction for allowing placement of next lift or public traffic changed to 60°C (from 50°C).
 - For bridge decks, HMA temperature immediately after spreading shall be at least the minimum temperature recommended by the AC supplier.
 - Breakdown rolling on structures shall commence immediately after spreading.
 - Replacement core no longer required when thickness is less than 35 mm.
 - Payment Adjustment for AC content is calculated with the ERS lot average AC content (instead of the JMF AC content).

- **Special Provision 103F03 or a Special Provision that deletes and replaces OPSS.PROV 313 in 2017 includes the changes above for Special Provision 103F02 and OPSS.PROV 313 November 2016 and the following changes:**
 - Incentives for mix properties and compaction have been suspended.
 - Compaction lower limit for acceptance has been raised to 92% with a 0.5 Tender Opening Date Reduction Factor (TODRF) for 2017. The payment factor determined this way will be compared to the payment factor determined using the lower limit of 90.5 or 91.5 and the lower payment factor will be used.
 - The rejection of poor quality asphalt pavement, and price reductions for lesser quality material and workmanship will continue.

- **Special Provision 111F06 amends OPSS.PROV 1151 and includes the following changes:**
 - The fine gradation band for 12.5 mixes is now the default, and the coarse graded band is invoked through a designer option.
 - The use of reclaimed asphalt pavement (RAP) and roof shingle tabs (RST) in the top layer of pavement is suspended.
 - The use of RAP and RST in binder course layers of pavement remains unchanged.
 - If RST is used in a binder course, RST test results for fibre content, asphalt cement (AC) content, gradation and recovered penetration will be submitted with the mix design.

Changes to Surface Smoothness

- **Special Provision 103F31 has been updated to include the following changes:**
 - Higher IRI requirements to qualify for incentives.
 - Category B pavement treatments added with different subplot payment factors based on IRI.
 - Localized Roughness payment reduction reduced by \$500.

Changes to Performance Graded Asphalt Cement (PGAC)

- **Special Provision 111F09 has been updated to include the following changes:**
 - Tender Opening Date Reduction Factor for Crack Tip Opening Displacement (CTOD) no longer applies.

- The Extended Bending Beam Rheometer (ExBBR) and Double Edge Notched Tension (DENT) tests have been implemented for acceptance on all contracts and for all grades of asphalt cement.
- Ash content acceptance limit has been lowered to 0.6 for all grades.
- Documentation from asphalt cement suppliers is now required certifying that the material conforms to the Ministry's requirements.
- Documentation from hot mix producers regarding asphalt cement storage has been added, and requirements for inspection and sampling for asphalt cement have been increased.

Changes to Emulsified Asphalt

- OPSS.PROV 1103 will be modified by NSSP to include the following changes:
 - The Code of Practice for the Reduction of Volatile Organic Compound (VOC) Emissions from Cutback and Emulsified Asphalt was published in the Canada Gazette, Part I, on February 25, 2017. This code of practice incorporates limits on VOC during the ozone season and recommended that emulsified asphalt manufactured, imported, offered for sale, sold or used in paving material for paving, construction or maintenance operations, have a VOC content equal to or less than 3% by volume which evaporates at 260°C (500°F) or less. Measurement of VOC is determined by the oil portion of distillate according to ASTM D6997 "Standard Test Method for Distillation of Emulsified Asphalt".
 - To adhere to this Code, MTO is adding limits to VOC content as determined by ASTM D6997 to OPSS.PROV 1103 emulsion specification and it will be published as NSSP soon.
 - Going forward, emulsified asphalt used on any contract shall be tested that it meets this additional VOC requirement and test results shall be emailed to bituminous@ontario.ca by the Contract Administrator.

Fibre Reinforced Hot Mix Asphalt

- In 2017, 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 **fibre reinforced and control** samples are to be sent to MERO Bituminous laboratory.
- For additional requirements, refer to the **Non-Standard Special Provision** included in the Contract Documents.

Performance Requirements for Surface Course Joints

- In 2017, 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 m² or greater within 150 mm of a surface course joint shall be repaired means approximately 200 mm x 200 mm or 8" x 8" or a circle with a diameter of 200 mm or any combination equaling 0.04 m² or 0.4 sq ft.
- For additional requirements, refer to the **Contract Special Provisions for Performance Requirements for Surface Course Joints and for Administration of Surface Course Joint Performance Specifications**.

Hot Mix Aggregates

- In addition to the physical property testing that's now being done on both lab-combined aggregates and aggregates extracted from hot mix samples, where a "D" (i.e. Dolomitic Sandstone) source is being used as the primary coarse aggregate in a "Premium" surface course mix:
 - Two separate duplicate samples must be taken from sampling pads constructed from aggregates taken from different portions of the aggregate stockpile at the plant and within

- two production shifts of the associated hot mix sample (i.e. that will be taken for petrographic testing/flats and elongates/Insoluble Residue testing).
- One portion of each of the two duplicate samples described above must be combined with the other hot mix aggregates, in accordance with the proportions given in the mix design, split on the 4.75 mm sieve and tested to ensure that the average insoluble residue (i.e. LS-613) of the two combined coarse fractions is no less than 45%.
 - Insoluble testing will also be conducted on the coarse portion of the aggregate extracted from the hot mix sample. The allowable insoluble residue of that sample must also be no less than 45%. However, in addition to that, the difference between that test result and the insoluble residue result from the average of the two combined aggregate samples “going in” will also be checked. That allowable difference will depend on if the mix contains RAP with >10% coarse aggregate, RAP with <10% coarse aggregate or no RAP at all.
 - For all “Premium” surface course mixes, there are also new changes in what will now be considered “Category 1” aggregates either when a “D” type primary coarse aggregate is used versus a “G”, “M” or “T” type, primary coarse aggregate for petrographic testing (LS-609), The allowable limit for the new “Category 1” requirements has also been slightly reduced (i.e. from 95% to 90%).
 - For SMA mixes, mineral filler must now be produced from quarried rock coming from the same bench that is used to produce a screenings co-product which has a Micro-Deval (LS-619) of no more than 30%. So additional samples of that product will now be required as well for MD testing.

Sample Delivery

- MTO implemented changes to Special Provision 199F57 in December 2016, moving from contractor sample delivery to owner/owner representative sample delivery.
- Please refer to the contract specific Special Provision 199F57 to verify who is responsible for the sample delivery and refer to the CA Agreement for individual CA contracts.
- The 2017 version of the CAITM has been updated to incorporate changes resulting from the move to owner/owner representative sample delivery.

Web-Based Contract Management Services (WBCMS MTO)

- 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 WBCMS MTO 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 desktops, laptops and or tablets.
- 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 is **now available and being used** for managing Material Quality Assurance Testing Services on contracts with the **Non-Standard Special Provision “AMENDMENT TO MTO GENERAL CONDITIONS OF CONTRACT, November 2016 - Use of WBCMS for Administering the Contract”**.
- 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 103F03 or a **Special Provision** that deletes and replaces OPSS.PROV 313, which for the purposes of this Field Guide will be referred to as “F03”;
- OPSS.PROV 1151, which for the purposes of this Field Guide will be referred to as “1151”;
- **Special Provision 111F06 that amends OPSS.PROV 1151, which for the purposes of this Field Guide will be referred to as “F06”;**
- 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. Use of WMA on Ministry Contracts is currently permissive, meaning a Contractor can use WMA instead of HMA. WMA mix design shall follow LS-318. 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 included in **F03** and **1151**.

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.

The Contractor should be asked if they intend to store hot mix production in a silo. If they do, the Contractor must submit the planned production times at least one Business Day ahead of each planned production time.

Additionally, if Superpave 9.5 is being used as padding the Contract Administrator should discuss at the pre-pave meeting whether or not the compaction requirements for the Superpave 9.5 mix will be waived.

The Contractor must submit the Technical Data Sheet and Safety Data Sheet for any release agent used.

1-2.1 Contractor Mix Design (1151)

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:

<u>Mix Type</u>	<u>Recommended Code</u>
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 1151 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 1151.

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 (F06)

Reclaimed Asphalt Pavement (RAP) and Roof Shingle Tabs (RST) are not permitted in any surface course with a design life of four years or more.

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 RST as well.

RST test results for fibre content, asphalt cement content, gradation and recovered penetration shall be submitted with the mix design. 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, & 1151)

The Contractor must submit the source of each aggregate prior to paving. If aggregates were treated with an Aggregate Anti-Stripping Treatment (**AST-AGG**) 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 (F03, 1101 & F09)

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 an **Asphalt Cement Anti-Stripping Treatment (AST-AC)** is added to the PGAC by the supplier:
 - i) how much **AST-AC** was added; and
 - ii) documentation from the PGAC supplier that the PGAC with the additive will meet AASHTO M 320 for the grade specified.

Prior to commencement of HMA production, the Contractor must submit for each grade of PGAC:

- a) **The bill of lading and certificate of analysis from the PGAC supplier, confirming the grade of PGAC for each grade and subsequent delivery of PGAC.**

- b) **Documentation identifying the storage tank the PGAC will be supplied from during HMA production. Prior to changing the storage tank, the Contractor must provide updated documentation.**

1-2.4.1 Prior to Use of PGAC with Asphalt Cement Anti-Stripping Treatment (1151)

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

or

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

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 **product (SS1 or SS1-HH)**, 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 **or diluted SS-1HH** will be permissible. Such requests are likely to be made for alternative 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 (F03)

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 F03. **The Contractor must also submit the minimum compaction temperature recommended by the AC supplier.**

1-3 Field Adjustments to the Job Mix Formula (F03)

The criteria for making field adjustments to the JMF are detailed in the Field Adjustments to the Job Mix Formula clause of F03.

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 F03, 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 F03). 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 **and sampling of the release agent are** 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 (F03)

2-2.1 Sampling for Density Testing of HMA Aggregates (F03)

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 F03.

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 (\pm 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.

2-2.2 Calculating VMA (F03)

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 F03).

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 6 of S12) shall be taken by the Contractor, for each subplot 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)

For physical properties, 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). **For Superpave 12.5FC 1, Superpave 12.5FC 2, SMA 9.5 and SMA 12.5 with a Type (D) primary coarse aggregate, two sets of duplicate samples will be obtained from separate sampling pads constructed from aggregate from different parts of the aggregate stockpile.** A sample 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. **Where a Mineral Filler is required for an SMA, in addition to the duplicate samples of the mineral filler itself, separate duplicate samples must also be taken of an unwashed "Screenings" co-product that's produced from the same bench as the mineral filler.**

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.

2-4 Sampling for Mix and Volumetric Properties (F03)

2-4.1 Sample Size (F03)

For all Superpave and SMA mixes, a set of two samples, each with masses of 20 to 45 kg (see Table 2 in F03) shall be taken by the Contractor, for each subplot (see Note 2-1, Note 2-2, and Note 2-3) in accordance with the Sampling subsection of F03. 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 F03). 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 F03).

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 F03).

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

2-4.2 Sampling Frequency (F03)

The sampling frequency is dependent on the lot size with the subplot 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 F03 (see section 2-9 for guidance on setting up lot and subplot 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 (F03)

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 F03 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 F03 and below).

What would normally be a 5,000 tonne lot, designed at 40 to 50 mm in thickness, will be a 40,000 m² 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 subplot would be 4,000 m² 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 F03 or using the following formula from F03:

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

Where:

- BRD_{MD} = the bulk relative density in t/m³, 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:

$$\text{Total Area of placement: } (25+195 - 22+245) \times 3.75 \times 2(\text{lanes}) = 22,125 \text{ m}^2$$

Since a typical subplot is 4,000 m² 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 F03, 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 m² but less than 40,000 m², 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 subplot 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 (F03)

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 subplot within a 5,000 tonne lot, i.e. Lot 3.

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

2. For each subplot, 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.

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

3. Using the random number determined for each subplot, 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 subplot size = tonne to be sampled

$$0.750 \times 500 = 375$$

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 subplot
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 subplot 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 F03 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 F03 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 F03 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 <u>6 x 8</u>	.25 x .25 <u>10 x 10</u>	.30 x .30 <u>12 x 12</u>	.35 x .35 <u>14 x 14</u>	.45 x .45 <u>18 x 18</u>	m 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 (F03)

In each subplot, 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 subplot, from a random number table (Appendix A:) or generated by a calculator or computer.

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

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

Example: Sublot 1 random # x length of subplot = Distance into subplot.
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 subplot = Distance into subplot.
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 subplot, 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 and Sampling of the Release Agent (F03)

In accordance with the Contract requirements and the Compaction clause under the Sampling subsection of F03, 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 subplot 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 F03. All sample locations shall be restored as given in step 12 below.

For each 500 tonne subplot, 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). The first number will be used to calculate the distance into the subplot 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 subplot 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: $13250 \div 10 = 1,325$ 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 subplot.

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 subplot = 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 **Business** Day following the completion of each subplot. However, if it is desired to obtain the cores immediately after the completion of the subplot, 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, subplot, 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 F03. 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.

In accordance with the Compaction clause under the Sampling subsection of F03 a 1 litre sample of the release agent(s) shall be delivered to the Contract Administrator upon request.

2-6 Core Sampling for Lift Thickness (F03)

2-6.1 Sample Size (F03)

In accordance with the Contract requirements and the Lift Thickness clause under the Sampling subsection of F03, 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 subplot to be designated as the subplot 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 subplot 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 F03. All sample locations shall be restored as given in section 2-5 (step 12).

2-6.2 Sampling Frequency (F03)

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 m² in size. A minimum of three sublots are required for each lot. All lifts below the surface course will have the same subplot 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: $(25+195 - 22+245) \times 3.75 \times 2(\text{lanes}) = 22,125 \text{ m}^2$

Total area in the shoulders: $(25+195 - 22+245) \times 2.50 \times 2(\text{shoulders}) = 14,750 \text{ m}^2$

Length of each subplot in the lanes: $2000 \div 3.75 \text{ m} = 533 \text{ m}$ (rounded to nearest m)

Length of each subplot in the shoulders: $2000 \div 2.50 \text{ m} = 800 \text{ m}$

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 (1068.75 m ²)
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	

6	25 + 195 -	24 + 947	(930 m ²)	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		Eastbound
13	23 + 045 -	23 + 845		
14	23 + 845 -	24 + 645		
15	24 + 645 -	25 + 195	(1352.5 m ²)	
15	25 + 195 -	24 + 936	(647.5 m ²)	Westbound
16	24 + 936 -	24 + 136		
17	24 + 136 -	23 + 336		
18	23 + 336 -	22 + 536		
19	22 + 536 -	22 + 245	(727.5 m ²)	

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 m² to: subplot length X lane width including shoulder = 533 X 4.25 = 2265.25 m². Any payment adjustment would be applied to this new subplot area instead of 2000 m².

2-6.3 Sampling Method and Random Sample Locations (F03)

Within each subplot, 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 subplot, 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 subplot 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 subplot.

Example: Sublot 1 0.235, 0.713
 Sublot 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 subplot = Distance into subplot.
 0.235 x 533 = 125.3 m or
 Sta. 22+245 + 125 = Sta. 22+370 EB

$$\begin{aligned} & \text{2nd random \# x pavement lane} \\ & \text{width for the lot} \\ & 0.713 \times 3.75 \qquad \qquad \qquad = \quad 2.69 \text{ m offset Right from} \\ & \qquad \qquad \qquad \qquad \qquad \qquad \qquad \qquad \qquad \text{Edge of Pavement (EP)} \end{aligned}$$

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

$$\begin{aligned} \text{Sublot 2} \quad & \text{1st random \# x length of subplot} = \text{Distance into subplot.} \\ & 0.732 \times 533 \qquad \qquad \qquad = \quad 390.2 \text{ m or} \\ & \text{Sta. 22+778} + 390 \qquad \qquad \qquad = \quad \text{Sta. 23+168 EB} \end{aligned}$$

$$\begin{aligned} & \text{2nd random \# x pavement lane} \\ & \text{width for the lot} \\ & 0.030 \times 3.75 \qquad \qquad \qquad = \quad 0.11 \text{ m offset Rt from EP} \end{aligned}$$

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 subplot'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.

The five core samples **previously required to be taken upon completion of gritting operations are no longer required.**

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 of 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 F03. 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 **F09**. 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 a **2-litre** sample (or **two** 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 a **2-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		Random No. for Tonne	"Tonne to be Sampled" =(Random No. X 10,000) + start tonne for lot
<u>Lot No.</u>	<u>Lot Size</u>		
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 **2**-litre sampling can (or **two** 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 **2**-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 **2**-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 (F03)

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 F03, 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 F03 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 2-9.2.

2-9.1 Paving on Bridge Decks and Staged Construction - All Item Quantities (F03)

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 (F03)

When a bridge deck or any construction stage is greater than 100 tonnes, 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 F03 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 F03 and chapter 3. Core samples shall not be taken on bridge decks.

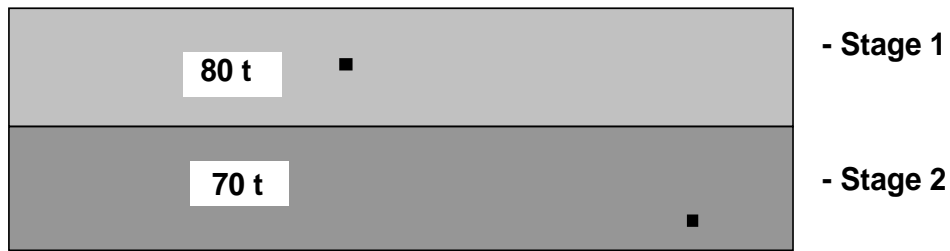
2-9.1.2 Bridge Decks and Construction Stages Less than 100 Tonnes (F03)

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

If a lot with a single subplot is selected, take one random set of two samples (see Table 2 of F03 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 F03.
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 F03.

2-9.2 Item Quantity Greater than 5,000 Tonnes (F03)

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 **and be** 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).

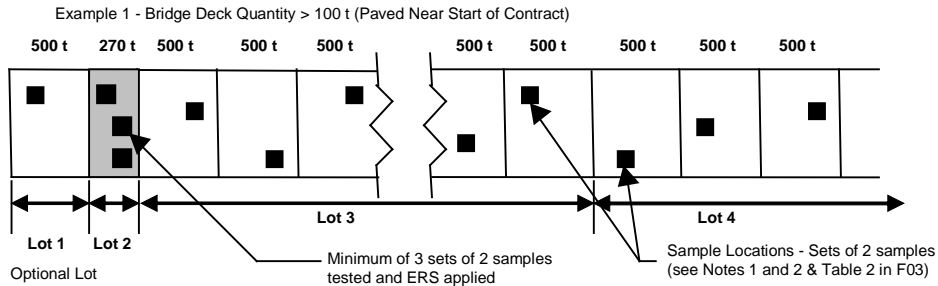
The remaining quantity of the tender item will normally be divided into 5,000 tonne lots, each with 10 equal sublots of 500 tonnes each. Various ways of planning the location of these lots are shown in the examples (in the following pages).

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

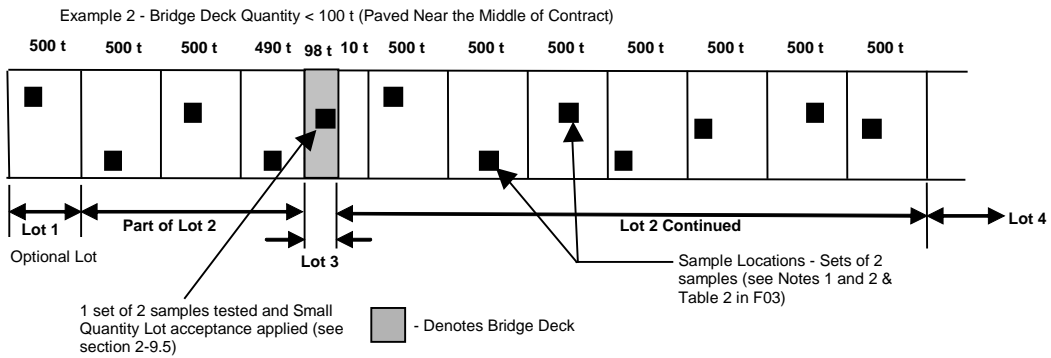
- a) If the remaining quantity is expected to be less than 1,000 tonnes, consider it as part of the previous lot.
- b) If the remaining quantity is expected to be greater than 1,000 tonnes, then the Contractor may request that the remaining quantity be considered as a separate lot with a minimum of three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

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

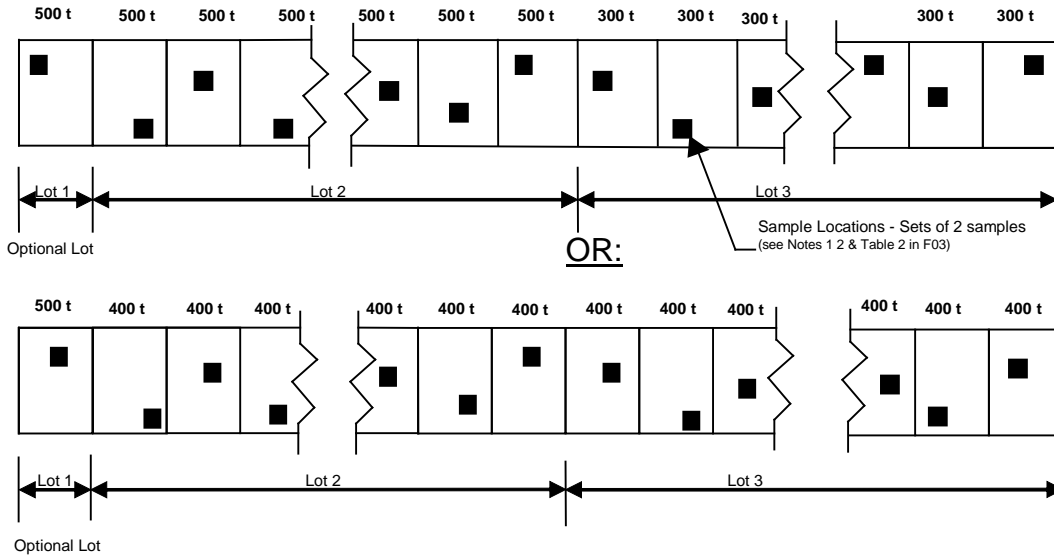
Paving Bridge Decks - Item Quantity = 15,000 tonnes



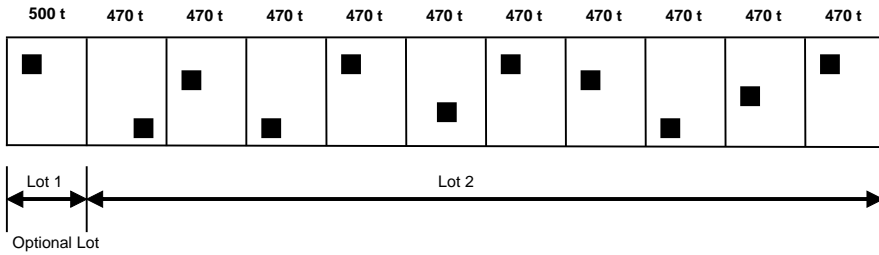
OR:



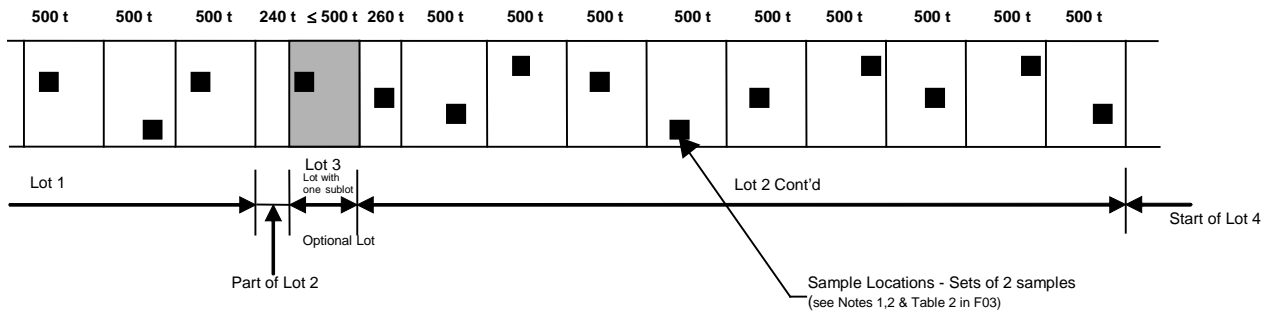
Example: Item Quantity = 8,500 t



Example: Item Quantity = 5,200 t

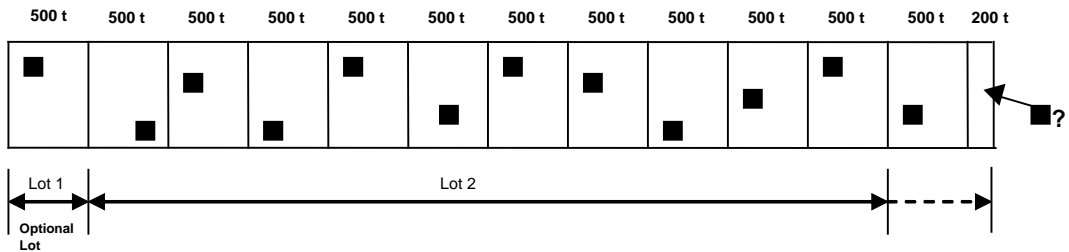


Example: Item Quantity > 5,000 t



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: Interrupted sequence of paving due to unforeseen stoppage or change in Job Mix Formula



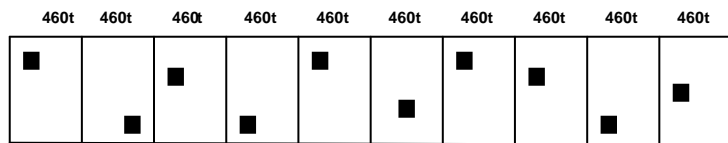
Note 2-14: The last 200 tonnes shown in the diagram (referred to by the “?”) would be a subplot if, by random numbers, a sample was required to be taken. Regardless of whether or not a sample is to be taken, the 200 tonnes is included in the total quantity of the previous lot.

2-9.3 Item Quantity 1,000 Tonnes to 5,000 Tonnes (F03)

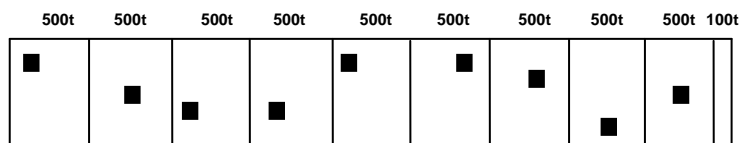
When the tender item quantity is between 1,000 tonnes and 5,000 tonnes, the quantity will normally be considered as one lot. The lot/sublot sizes can be reduced at the discretion of the Contract Administrator and after discussion with the Contractor. If possible, the subplot sizes should be of equal 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: Item Quantity = 4,600 t



NOT



2-9.4 Item Quantity Less than 1,000 Tonnes (F03)

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 F03.

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) (F03)

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 F03 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 F03. 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 F03.

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

<u>Sublot 1: Test Results</u>	<u>Acceptance Criteria</u>	<u>Accept/ Reject</u>
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	92.0 to 97.0	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 F03 and the VMA is not 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.

<u>Sublot 2: Test Results</u>	<u>Acceptance Criteria</u>	<u>Accept/ Reject</u>
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	92.0 to 97.0	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 subplot do not comply with the limits in Table 5 of F03. Therefore, subplot 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:

$$\begin{aligned}
 PF_{AC} &= 0.700 \\
 PF_{DLS} &= 1.000 \\
 PF_{4.75} &= 0.450 \\
 PF_{75} &= 1.000 \\
 PF_{AV} &= 1.000 \\
 PF_C &= 1.000 \\
 PF_{VMA} &= 1.000
 \end{aligned}$$

Then PF_{MC} is calculated for the subplot using the formulae in the Calculations clause of F03 as follows:

$$\begin{aligned}
 PF_G &= (PF_{DLS} + PF_{4.75} + PF_{75}) / 3 \\
 PF_G &= (1.000 + 0.450 + 1.000) / 3 \\
 PF_G &= 2.450 / 3 = 0.8167
 \end{aligned}$$

$$\begin{aligned}
 PF_{GAC} &= (PF_G + PF_{AC}) / 2 \\
 PF_{GAC} &= (0.8167 + 0.700) / 2 \\
 PF_{GAC} &= 1.5167 / 2 = 0.7584
 \end{aligned}$$

$$\begin{aligned}
 PF_{VMA} &= 1.000, \text{ therefore:} \\
 PF_{VOIDS} &= PF_{AV} = 1.000
 \end{aligned}$$

$$\begin{aligned}
 PF_M &= (PF_{GAC} + PF_{VOIDS}) / 2 \\
 PF_M &= (0.7584 + 1.000) / 2 \\
 PF_M &= 1.7584 / 2 = 0.8792
 \end{aligned}$$

$$\begin{aligned}
 PF_{MC} &= (PF_C + PF_M) / 2 \\
 PF_{MC} &= 1.000 + 0.8792 \\
 PF_{MC} &= 1.8792 / 2 = 0.9396
 \end{aligned}$$

$PF_{MC} = 0.9396$ would be applied to the subplot 2 quantity for a payment adjustment calculated using the formula in the Payment Adjustment for Mix Properties and Compaction clause of F03.

Chapter Three

REPORTING HOT MIX ASPHALT TEST RESULTS

3-1 General (F03)

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 103F03 or a **Special Provision** that deletes and replaces OPSS.PROV 313 will be referred to as “F03” 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 2-9.2 and 2-9.5).

The Owner will conduct tests, carry out calculations, and provide values according to Table 4 of F03. 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 F03.

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:

For Contracts with SP 103F03: ERS - Hot Mix Asphalt Pay Factor Calculation Form PH-CC-868C “ERS 2017 – Hot Mix Asphalt Payment Calculation.”

For Contracts with SP 103F02: ERS - Hot Mix Asphalt Pay Factor Calculation Form PH-CC-868B “ERS 2017 – Hot Mix Asphalt Payment 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 affect the payment factor. 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 (F03)

The test results from the mix properties and compaction testing for each subplot 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 Payment Calculation Spreadsheet (F03)

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 **and that are not rejectable**.

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

<u>TAB NAME</u>	<u>SHEET</u>
Guide	Basic User Information
General	Input Data and Summary of Payment Adjustments
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

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 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 subplot 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 **'General' sheet** is used to enter the general Contract information. The general Contract information is input in the blue shaded cells and will automatically be repeated on the **'QA'**, **'REF'**, **'AddData'**, and **'FIN'** sheets. The Region, Mix Type, Mix Designation, course and **unit of measure** can be selected from drop-down menus. 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. 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 **E32**; otherwise "No" should be selected. For RBM, a box will appear in cell **B9** for inputting the design air voids.

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.

2. The **'QA'** sheet is used to enter the QA test results **and display the calculations to determine the intermediate pay factors**. The QA test data should be input into the blue-shaded areas of the 'Sublot Data Input' table. The subplot 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 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 on the **General sheet** (in red font) must be entered in order to see the final pay factor (PF_{MC}).
3. The **'REF'** sheet should be used only to input referee test results when referee testing has been invoked for one subplot, two sublots, or all of the sublots. The name of the referee laboratory and the date of referee testing **should be entered on the General sheet**. 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.
4. 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 **General sheet**.
5. The **'OutC'** sheet is used to check any group of subplot test results for outliers. Enter the number of sublots in cell D3, the suspected outlier result in cell D4 and the other subplot 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.
6. 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 **E43**). Ensure that no unnecessary data has been entered in the REF sheet and all required information has been entered on the **General** sheet to get

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

7. The 'PA' sheet is used to display the payment adjustment calculations for aggregate density, asphalt cement content, PGAC price index and segregation. The final total payment adjustment is shown at the bottom of the General sheet.

3-3.2 Using the Spreadsheet for Square Metre Items (F03)

The spreadsheet described above, may be used for payment by square metre Contracts except that on the **General sheet**, the lot size should be input into cell **B16** in m², instead of tonnes (t) and "m²" should be selected **as the unit of measure** from the drop down menu in cell **B13**. Everything else will remain the same.

3-4 Reporting Lift Thickness Test Results (F03)

The lift thickness measurements shall be determined based on lift thickness of the single pavement core sample for each subplot 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 subplot 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 (F03)

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 number of rows **will automatically adjust**.
3. The spreadsheet also assumes each subplot to be 2,000 m². However, for any sublots that are not 2,000 m², 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 16), and the appropriate thickness measurements (**row 31 and beyond as applicable**). Once these are entered, the spreadsheet will calculate the thickness penalty for each item, and the overall penalty for the Contract will be shown **in cell C22**.

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 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, **non-conformance**, 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 2017 - Hot Mix Asphalt Payment Calculation

QA LOT PAY FACTOR CALCULATION

April 2017 103F03 Version

Contract	2016-XXXX	Lot No.	4		
Highway	X	Lot Size	4000	m2	
Region	West	No. Sublots	10		
Mix Type	SUP125	Date Paved	2017-Jul-05		
Mix Designation	Warm Mix	Date Tested	2017-Jul-07		
Item No.	3	% RAP	0		
		Course	Surface		
		Design Thickness	40	mm	

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

JMF Id.	DLS - 9.5 mm	4.75 mm	75 µm	AC Content	Air Voids	Compaction	VMA
73.5	73.5	51.8	3.8	4.6			14.0
Sublot 1	78.9	54.5	3.9	4.40	4.2	94.6	15.10
Sublot 2	76.3	55.9	4.1	4.30	4.0	92.8	14.80
Sublot 3	76.3	54.1	1.9	4.40	4.0	93.0	14.60
Sublot 4	69.9	45.3	3.7	4.20	4.3	93.5	14.90
Sublot 5	77.7	54.7	4.2	4.40	3.8	92.3	14.80
Sublot 6	73.1	50.7	4.1	4.30	3.8	92.8	13.90
Sublot 7	78.7	55.1	2.8	4.80	3.7	92.3	13.90
Sublot 8	78.0	57.3	4.4	4.40	2.8	92.6	14.50
Sublot 9	76.1	54.8	4.4	4.40	3.7	92.5	14.70
Sublot 10	68.8	46.9	3.1	4.10	4.6	91.0	14.20
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	92.7	14.5
Std Dev	3.60	3.98	0.82	0.18	0.48	0.92	0.41
LL	68.5	46.8	1.8	4.2	2.5	92.0	
UL	78.5	56.8	5.8	5.1	5.5	97.0	
QL	1.92	1.53	2.32	1.11	2.92	0.76	
QU	0.86	0.98	2.56	3.89	3.33	4.67	
PL	99	95	100	87	100	78	
PU	81	84	100	100	100	100	
PWL	80	79	100	87	100	78	
PF	0.986	0.983	1.000	1.000	1.000	0.948	1.000

Calculation of Total Pay Factor

PF _G =	0.9897	PF _M =	0.9974
PF _{AC} =	1.0000	PF _C =	0.9475
PF _{GAC} =	0.9948	PF_{MC} =	0.9725
PF _{VOIDS} =	1.0000		

Copy to: Regional Quality Assurance Contract Administrator Contractor Originator

April 2017 Thickness ERS - Payment Adjustment Calculation

CONTRACT	2016-XXXX	LOT NO.	8
HIGHWAY	X		
REGION	N-Western	# OF SUBLOTS	15

All green cells must be filled to get Payment Adjustment for Lift Thickness.

* 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 Administrator.

	Surface Course	Binder and Other Courses					
Mix Type	SUP125	SUP190					
Design Thickness (mm)	40	50					
Minimum Thickness (mm)	30	40					
Item No.	9	10					
Price*	13.70	15.00					
COUNT	15	15	0	0	0	0	0
Lot Mean Thickness	39.3	48.5	0.0	0.0	0.0	0.0	0.0
TL	39.3	48.5	0.0	0.0	0.0	0.0	0.0
Payment Adjustment for each Course	\$14,385.00	\$13,500.00					
Total Lot Area	30000.00						
Total Payment Adjustment for Lot Thickness	\$27,885.00						

	Surface Course	Binder and Other Courses						
Mix Type	SUP125	SUP190						
Design Thickness (mm)	40.00	50.00						
Minimum Thickness (mm)	30	40						
Item No.	9	10						
Price*	14	15						
Sublot #	Sublot Area (m ²)	Core Thickness	Core Thickness	Core Thickness	Core Thickness	Core Thickness	Core Thickness	Core Thickness
1	2000	45.5	45					
2	2000	47	55					
3	2000	41	48					
4	2000	39	51.5					
5	2000	29	52					
6	2000	44	49.5					
7	2000	37.5	48.5					
8	2000	32	49					
9	2000	41.5	39					
10	2000	35.5	45					
11	2000	40	45.5					
12	2000	42	51					
13	2000	37	50.5					
14	2000	37.5	49.5					
15	2000	41	48					



PGAC Test Reporting Sheet

Contract No.: <input style="width: 80%;" type="text" value="2016-XXXX"/>	Region: <input style="width: 80%;" type="text" value="East"/>	Date: <input style="width: 80%;" type="text" value="5-May-17"/>
Lab: <input style="width: 80%;" type="text" value="ABC Labs
Kingston"/>	PGAC Lot: <input style="width: 80%;" type="text" value="1"/>	MSCR Test Temperature: <input style="width: 80%;" type="text" value="58"/>
	HMA Lot: <input style="width: 80%;" type="text" value="3"/>	
	HMA Sublot: <input style="width: 80%;" type="text" value="2"/>	
Sample No.: <input style="width: 80%;" type="text" value="4900"/>	QA: <input checked="" type="checkbox"/>	DENT Test Temperature: <input style="width: 80%;" type="text" value="15"/>
	Referee: <input type="checkbox"/>	
PG Grade: <input style="width: 80%;" type="text" value="58-34"/>	AC Supplier: <input style="width: 80%;" type="text" value="Asphalt R US"/>	

Notes:

1. This form is to be used on Contracts with SSP111F09/111F09M.
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 G30 if choosing non-compliant. If compliant leave cell G30 blank.
5. 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.

	Results (Note 2)	Limits (Note 3)	Meets Requirements (Note 3)
PGAC Compliance			
Performance Grading (AASHTO R 29):			
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 (%)	0.70	<= 0.60	MAJOR BORDERLINE
Multiple Stress Creep Recovery (AASHTO T 350):			
Non-recoverable Creep Compliance at 3.2 kPa, $J_{nr3.2}$ (kPa^{-1})	2.05	< 4.50	YES
Average Percent Recovery at 3.2 kPa, $R_{3.2}$ (%)	14.2	> 24.3	NO
Difference Non-recoverable Creep Compliance, $J_{nr diff}$ (%)	29.7	Info Only	Info Only
Double Edge Notched Tension Test (LS-299):			
δ_t , CTOD, average (mm)	10.3	>= 14.0	Non-Conformance
Extended Bending Beam Rheometer (LS-308):			
Low Temperature Limiting Grade, LTLG ($^{\circ}C$) (Note LTLG is the warmest Limiting Grade)	-28.4	<= -34	MAJOR BORDERLINE
Grade Loss ($^{\circ}C$)	-4.9	<= -6.0	YES

Technician:

PRINT NAME	SIGNATURE	DATE

Reviewed by:

PRINT NAME	SIGNATURE	DATE

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 F03 (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 (1151 & F03)

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 **1151** 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 **60°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.

At the prepave meeting, the Contractor may ask to place the next course or open to public traffic before meeting this temperature requirement. This should be considered on a case-by-case basis and discussed with the Regional Quality Assurance Section. Some possible situations in which the temperature requirement may be waived includes: where there are lane closure restrictions that prevent cooling to 60°C or interchanges.

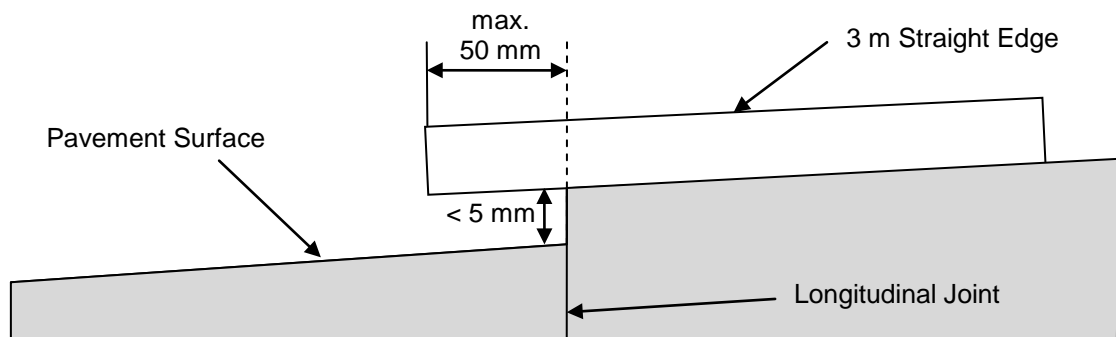
4-3 Acceptance of Surface Tolerance (F03)

Acceptance of surface tolerance will be in accordance with the Surface Tolerance clause of F03. 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 (F03)

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 (F03)

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 F03.

4-4.1.1 Initial Notification / Corrective Action for Segregation (F03)

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 (F03)

Mid-lane Segregation occurring in HMA shall be dealt with as detailed below:

1. Slight Mid-lane Segregation:
Slightly segregated mix will be accepted into the work with no payment reduction.
2. Medium and Severe Mid-lane Segregation:
The Contract Administrator will determine if medium or severe mid-lane 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 (F03)

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 F03. 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

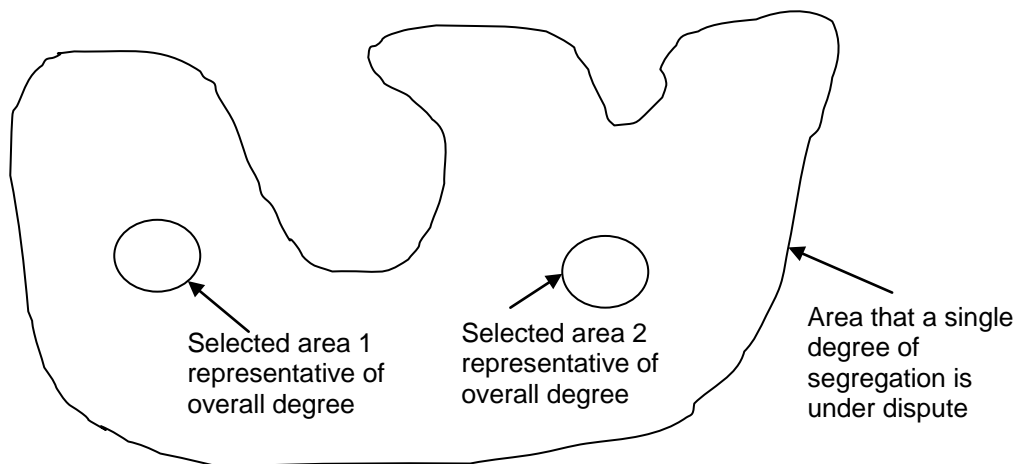
Table 4-1 (or Table 1 of LS-317 and Table 8 of F03) may be used to determine the maximum allowable macrotexture depth for a non-segregated area as well as the degree of severity of an adjacent disputed area of segregation. The results of this testing shall be binding on both the Owner and the Contractor.

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 (F03)

4-5.1 Pavement Width (F03)

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 (F03)

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 F03. 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 (F03)

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 (F03)

4-7.1 Payment for Repairs (F03)

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 (F03)

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 F03.

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 1 to 5 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 (F03)

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 subplot 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 subplot are calculated according to the following formulae:

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

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

Where: \bar{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 of **F03** in combination with the formulae and associated Table 1 given in LS-101 (Appendix C).

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 **F03**. 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_103F03) 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.rags.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 (F03)

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 (F03)

Acceptance of square metre items will be 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 (F03)

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 **F03**.
- 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 **F03**.
- c) a core taken for compaction testing does not meet the minimum lift thickness specified in Table 9 of **F03**.

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

If the lot mean is \geq 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 **F03**.

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 **F03** 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 subplot is not to be repaired, the subplot shall be subject to the following Sublot Thickness Payment Adjustment:

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

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 $\leq 3^{\circ}\text{C}$ above the design LT, and
- b) test results show the HT $\leq 3^{\circ}\text{C}$ below the design HT, and
- c) $[(\text{LT} - \text{design LT}) + (\text{design HT} - \text{HT})] \leq 3^{\circ}\text{C}$.

Major Borderline (accepted with a payment reduction) if:

- a) test results show the LT $\leq 3^{\circ}\text{C}$ above the design LT, and
- b) test results show the HT $\leq 3^{\circ}\text{C}$ below the design HT, and
- c) $[(\text{LT} - \text{design LT}) + (\text{design HT} - \text{HT})] > 3^{\circ}\text{C}$ but $\leq 6^{\circ}\text{C}$.

The payment reduction for the HMA quantity produced using major borderline PGAC = $0.05 \times \text{HMA Contract price} \times \text{quantity of HMA in the lot}$.

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 **or F09(M)**. 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 **F09** 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. 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 **are several** Contracts with differing acceptance criteria.

The Multiple Stress Creep Recovery (MSCR) test acceptance is based on the non-recoverable creep compliance and the average percent recovery at 3.2 kPa. Figure 5-1 shows an example of how three average percent recovery at 3.2 kPa results would be categorized.

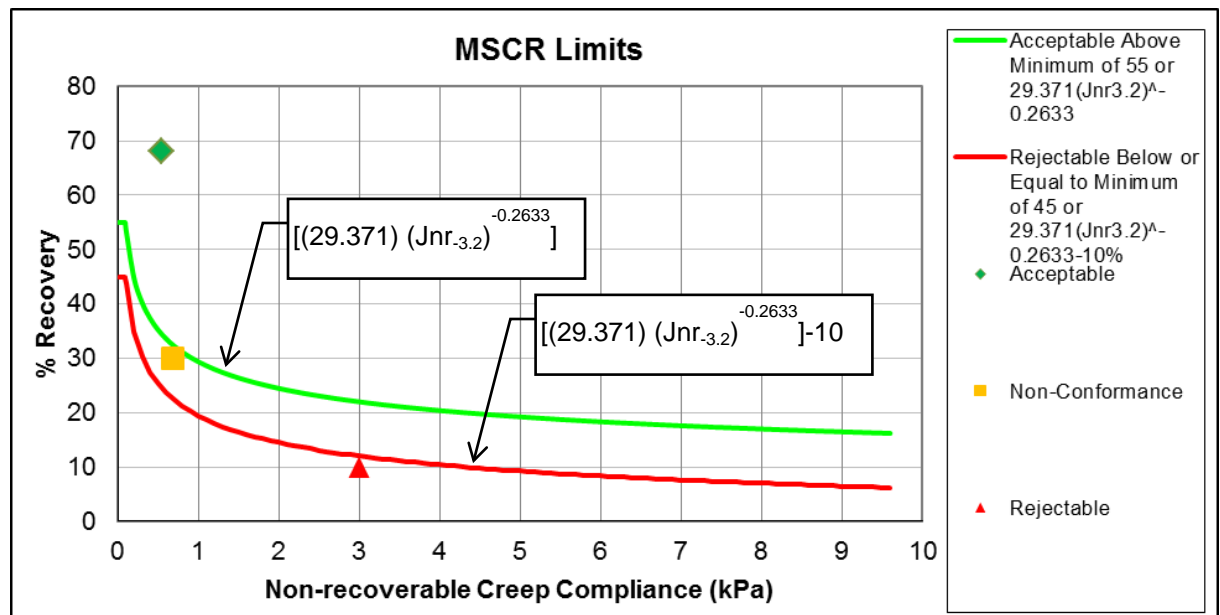
The upper (green) line is the acceptance criteria and any result above this line is acceptable, such as the “Acceptable” test result (green diamond) of 0.55 kPa non-recoverable creep compliance and 68% average percent recovery at 3.2 kPa.

The lower (red) line is the rejectable limit and any result on or below this line is rejectable, such as the “Rejectable” test result (red triangle) of 3.0 kPa non-recoverable creep compliance and 10% average percent recovery at 3.2 kPa.

If a test result falls between the upper (green) and lower (red) line or on the upper (green) line it is a non-conformance, such as the “Non-Conformance” test result (yellow square) of 0.69 kPa non-recoverable creep compliance and 30% average percent recovery at 3.2 kPa.

Note 5-1: In this example, all of the non-recoverable creep compliance values are acceptable (less than 4.50 kPa⁻¹).

Figure 5-1: MSCR Average Percent Recovery Limits Example



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 (F03)

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 subplot(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.rags.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 5-2: 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 (F03)

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 F03.

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 5-3: 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 subplot, and use this value in the calculation of compaction for the referee core.

5-3.5 Referee Testing for Lift Thickness (F03)

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 (F03)

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 5-6 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 5-4: 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

<u>Sublot No.</u>	<u>AC Content (%)</u>
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 subplot 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 \bar{X} , and standard deviation, s for the ten values:

$$\bar{X} = 4.825; \quad s = 0.1758$$

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:

$$(3) \quad T_m = \frac{|X_m - \bar{X}|}{s}$$

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

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

<u>Sublot No.</u>	<u>% <4.75 mm sieve</u>
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 subplot 2 may not come from the same population as the other values. The mean of the ten values is $\bar{X} = 53.950$ and the standard deviation is $s = 3.7263$. From these values, we therefore compute T_2 for subplot 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 subplot 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 subplot containing the outlier will be treated as a lot with one subplot for both mix properties and compaction. The remaining sublots will then form a separate lot.

Note 5-5: 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 5-6: 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 (F03)

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 (F03)

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 (F03)

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 (F03)

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.

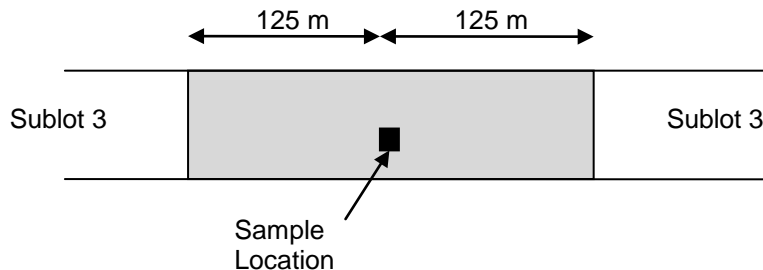
Whenever repair work is to be carried out, the Contractor has to determine the area(s) to be repaired. However, the Owner will determine where the original sublots actually started and ended using weigh ticket information and/or diary records. The Owner should not give any advice regarding the areas 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 F03. Each repair area must:

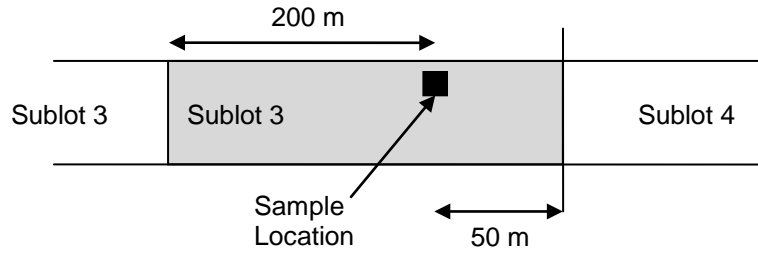
1. Include at least one of the loose mix or core sample locations and the limits must be at least 125 lane-metres from the sample location, otherwise the limit will be the end of the subplot;
2. Be a minimum length of at least 250 lane-metres or, if a repair extends into another lane, no portion of a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

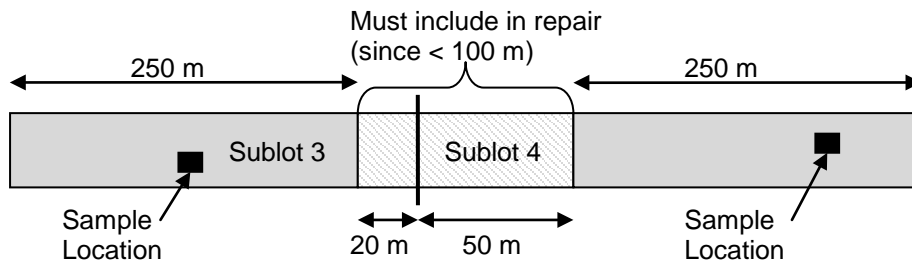
a) Typical Sublot Repair



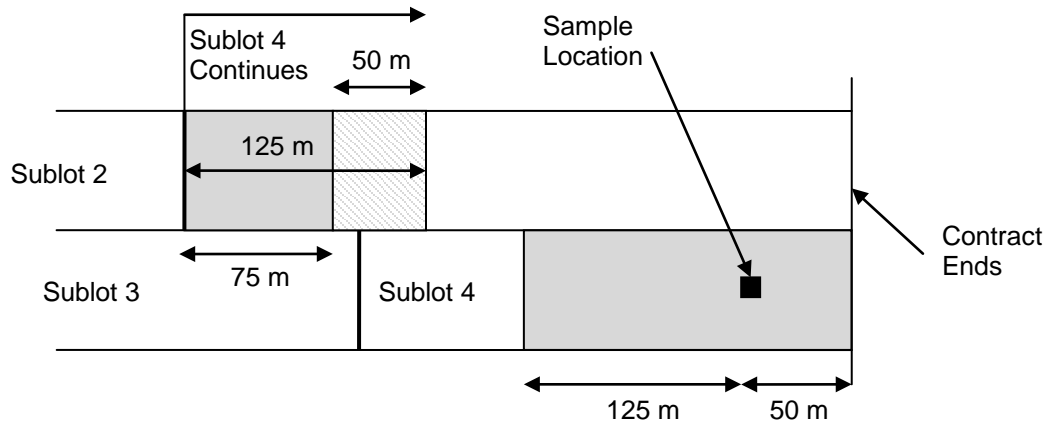
b) Sublot Repair Near End of Sublot



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 F03. 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 (F03)

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

5-5 Example Calculations for PWL and Combined Payment Factors (F03)

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 2017- Hot Mix Asphalt Payment Calculation" was determined from the EXCEL® computer program described in chapter 3.

ERS 2017 - Hot Mix Asphalt Payment Calculation

FINAL COMPOSITE LOT PAY FACTOR CALCULATION

April 2017 103F03 Version

Contract	2016-XXXX	Lot No.	4	m2	PLEASE CHECK REFEREE PAGE TO ENSURE THAT NO UNNECESSARY DATA IS INCLUDED
Highway	X	Lot Size	4000		
Region	West	No. Sublots	10	Design Thickness	40 mm
Mix Type	SUP125	Date Paved	2017-Jul-05	Course	Surface
Mix Designation	Warm Mix	Tested (QA)	2017-Jul-07	Tested (Referee)	2017-Aug-01
Item No.	3	% RAP	0		

Sublot Data Input							Did a JMF adjustment to this lot result in a decrease in the design %AC?	No
JMF Id.	DLS - 9.5 mm	4.75 mm	75 µm	AC Content	Air Voids	Compaction	VMA	
73.5	73.5	51.8	3.8	4.6	4.2	94.6	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	91.0	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	92.7	14.5
Std Dev	3.60	3.98	0.82	0.18	0.48	0.92	0.41
LL	68.5	46.8	1.8	4.2	2.5	92.0	
UL	78.5	56.8	5.8	5.1	5.5	97.0	
QL	1.92	1.53	2.32	1.11	2.92	0.76	
QU	0.86	0.98	2.56	3.89	3.33	4.67	
PL	99	95	100	87	100	78	
PU	81	84	100	100	100	100	
PWL	80	79	100	87	100	78	
PF	0.986	0.983	1.000	1.000	1.000	0.948	1.000

See Bottom of General Page for
Final Payment Adjustments

Calculation of Total Pay Factor

PF _G =	0.9897
PF _{AC} =	1.0000
PF _{GAC} =	0.9948
PF _{VOIDS} =	1.0000

PF _M =	0.9974
PF _C =	0.9475
PF_{MC} =	0.9725

Copy to: Regional Quality Assurance Contract Administrator Contractor Originator

1) Percent Within Limits Calculation

DLS (9.5 mm) Sieve Data for Superpave 12.5 Mix

78.9	76.3	76.3	69.9	77.7
73.1	78.7	78.0	76.1	68.8

- (i) Calculate the Mean (\bar{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:

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

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

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

$$\begin{aligned} \text{Mean, } \bar{X} &= \frac{78.9 + 76.3 + \dots + 68.8}{10} \\ &= 75.4 \end{aligned}$$

$$\begin{aligned} \text{Standard Deviation,} \\ s &= \sqrt{\frac{(78.9 - 75.4)^2 + (76.3 - 75.4)^2 + \dots + (68.8 - 75.4)^2}{9}} \\ &= 3.60 \end{aligned}$$

- (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 F03:

$$\begin{aligned} Q_L &= \frac{\bar{X} - LL}{s} \\ &= \frac{75.4 - 68.5}{3.60} = 1.92 \end{aligned}$$

$$\begin{aligned} Q_U &= \frac{UL - \bar{X}}{s} \\ &= \frac{78.5 - 75.4}{3.60} = 0.86 \end{aligned}$$

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:

$$P_L = 99 \quad \text{From } Q_L = 1.92$$

$$P_U = 81 \quad \text{From } Q_U = 0.86$$

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

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

$$= (99+81) - 100$$

$$= 80$$

(v) From Table 7 at the end of F03, the Payment Factor for DLS is determined to be 0.9860.

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 μ m sieve	=	1.0000
PF_{AC}	=	Payment Factor for Asphalt Cement	=	1.0000
PF_{AV}	=	Payment Factor for Air Voids	=	1.0000
PF_C	=	Payment Factor for Compaction	=	0.9475
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 (3) in the Payment Factor for Gradation clause of F03, Calculate PF_G :

Since the mix involved is a Superpave 12.5, PF_G is as follows:

$$\begin{aligned}
 (3) \quad PF_G &= (PF_{DLS} + PF_{4.75} + PF_{75}) / 3 \\
 PF_G &= (0.9860 + 0.9830 + 1.0000) / 3 \\
 &= \mathbf{2.969 / 3} \\
 &= \mathbf{0.9897}
 \end{aligned}$$

For Superpave 9.5, Superpave 4.75 and SMA 9.5, from Formula (4) in the Payment Factor for Gradation clause of F03, Calculate PF_G :

$$(4) \quad PF_G = (PF_{4.75} + PF_{75}) / 2$$

Since the mix involved is Superpave 12.5, do not use Formula (4).

b) Combined Gradation and Asphalt Cement Content

From Formula (5) in 313, Calculate PF_{GAC} :

$$\begin{aligned} (5) \quad PF_{GAC} &= (PF_G + PF_{AC}) / 2 \\ &= (0.9897 + 1.0000) / 2 \\ &= \mathbf{1.9897} \\ &= \mathbf{0.9948} \end{aligned}$$

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 (6) or (7) in F03 i.e.:

$$(6) \quad \text{If } (VMA_{\min} - VMA_{\text{mean}}) \geq 2.5, \text{ then } PF_{VMA} = 0$$

$$(7) \quad \text{If } (VMA_{\min} - VMA_{\text{mean}}) < 2.5, \text{ then:}$$

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

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 (8) or (9) in F03 i.e.:

$$(8) \quad \text{If } (VMA_{\min} - VMA_{\text{mean}}) \geq 3.0, \text{ then } PF_{VMA} = 0$$

$$(9) \quad \text{If } (VMA_{\min} - VMA_{\text{mean}}) < 3.0, \text{ then:}$$

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

d) Comparing the Payment Factors of Air Voids and VMA

Since PF_{VMA} is equal to 1.000:

$$PF_{VOIDS} = PF_{AV} = \mathbf{1.0000}$$

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 (10) in **F03**, Calculate PF_M :

$$\begin{aligned} (10) \quad PF_M &= (PF_{GAC} + PF_{VOIDS}) / 2 \\ &= (0.9948 + 1.0000) / 2 \\ &= 1.9948 / 2 \\ &= 0.9974 \end{aligned}$$

f) Combined Mix Properties and Compaction

Calculate PF_{MC} Using Formula (11) in **F03** for **SMA** mixes:

$$(11) \quad PF_{MC} = PF_C + PF_M$$

Since the mix involved is a Superpave 12.5 with a Tender Opening in 2017 do not use Formula (11), instead use Formula (12) in F03.

Calculate PF_{MC} from Formula (12) in **F03**:

$$(12) \quad PF_{MC} = (PF_C + PF_M) / 2$$

Where:

PF_C is the lower of the following calculations:

- a) $PF_C = [1 - \{0.5 \times (1 - PF_{C(SUB)})\}]$ where **PWL** and $PF_{C(SUB)}$ for compaction are determined using the lower limit specified in Table 5

$$PF_C = [1 - \{0.5 \times (1 - 0.8950)\}]$$

$$PF_C = 0.9475$$

- b) $PF_C = PF_{C(SUB)}$ where **PWL** and $PF_{C(SUB)}$ for compaction are determined using a lower limit of 90.5 or 91.5% as follows:

Superpave 12.5 and 12.5FC1	91.5%
Superpave 12.5FC2, Design Lift Thickness <50 mm	90.5%
Superpave 12.5FC2, Design Lift Thickness ≥50 mm	91.5%
Superpave 37.5, 25.0 and 19.0, Design Lift Thickness <60 mm	90.5%
Superpave 37.5, 25.0 and 19.0, Design Lift Thickness ≥60 mm	91.5%

Since the mix involved is a Superpave 12.5, a lower limit of 91.5% is used to determine the **PWL and $PF_{C(SUB)}$:**

Mean = 92.7

Standard Deviation = 0.92

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

$$= \frac{92.7 - 91.5}{0.92} = 1.30$$

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

$$= \frac{97.0 - 92.7}{0.92} = 4.67$$

$$P_L = 91 \quad \text{From } Q_L = 1.30$$

$$P_U = 100 \quad \text{From } Q_U = 4.67$$

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

$$= (91 + 100) - 100$$

$$= 91$$

From Table 7 at the end of F03, $PF_{C(SUB)}$ is determined to be 1.000.

Comparing a) $PF_C = 0.9475$ to b) $PF_C = 1.000$ the lower is selected as PF_C .

$$\text{Therefore, } PF_C = 0.9475 \text{ and } PF_{MC} = (PF_C + PF_M) / 2$$

$$= (0.9475 + 0.9974) / 2$$

$$= 0.9725$$

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 (F03)

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 **actually used during construction** as shown in section 5-6.2 and the Payment Adjustment for Asphalt Cement Content clause of F03. 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 F03.

5-6.1 HMA Quantity Calculation (F03)

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 F03.

5-6.2 Payment Adjustment for AC Content (F03)

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 **by lot** using the formula shown in the Payment Adjustment for Asphalt Cement Content clause of F03. **This payment adjustment is now based on the difference between the asphalt cement content specified for bidding purposed in the Contract Documents (AC_{BID}) and the average asphalt cement content of the lot (AC_{ERS}).**

5-6.3 Payment Adjustment for Changes in the AC Price Index (F03)

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 F03.

The payment adjustment per tonne will apply to the quantity of new AC in the HMA accepted into a lot in the work and will use the adjustment for the month for which the majority of the lot was placed. 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 (F03)

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 in the Payment Adjustment for Aggregate Density clause of F03.

5-8 Payment for HMA Miscellaneous Items (F03)

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 versions 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 (F03)

The requirements for surface tolerance using a straight edge, which are included in the Surface Tolerance clause of F03, 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 begins **when** the Contractor has clearly marked out the sublots and removed any debris from the pavement to the satisfaction of the Contract Administrator.

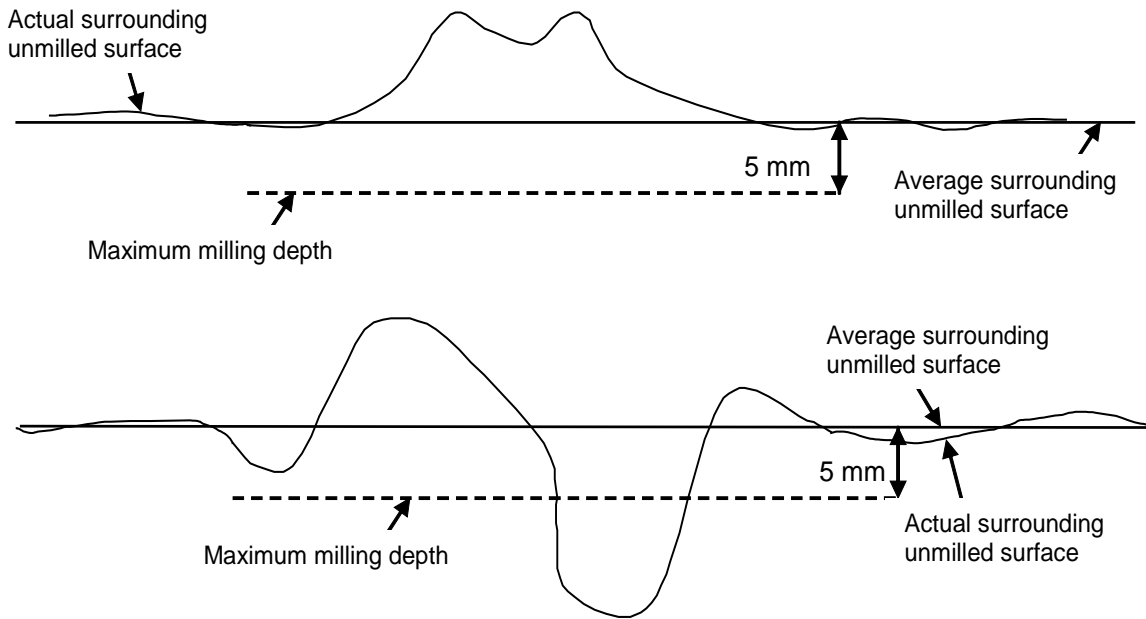
6-4 Smoothness Correction of Pavement beneath Surface Courses (F03)

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 F03. This padding shall be a mix type acceptable to the Owner.

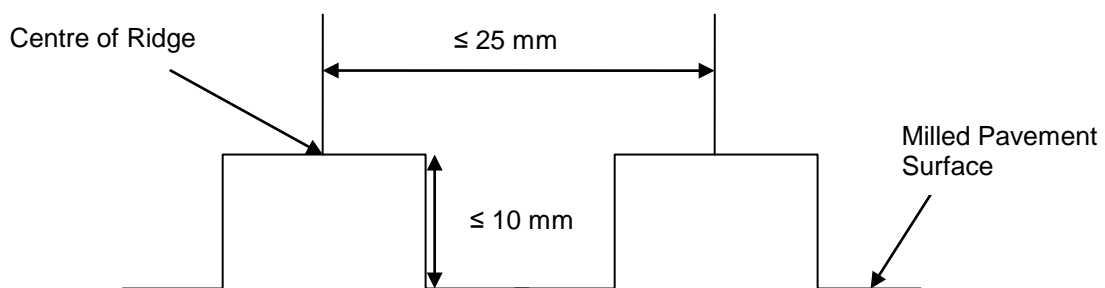
Grinding or milling will also be allowed for such corrections of any pavement underlying a surface course, but only if the thickness of those pavements after grinding or milling is not reduced by more than 5 mm below the general profile of the surrounding unground or unmilled pavement surface (see Figure 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 subplot sketch shall be finalized prior to the start of paving.

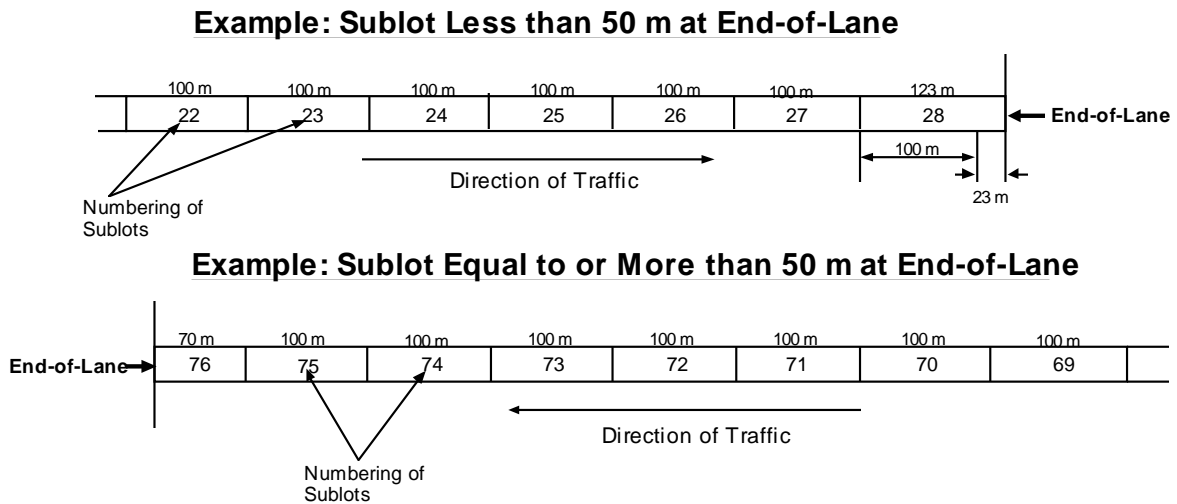
The Contractor should be aware that no other areas may be excluded from the requirements for surface smoothness measurements (unless damage occurs due to circumstances beyond the Contractor's control) once paving of the surface course begins.

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 subplot in the lane.

If, after the last complete subplot 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 subplot in the lane.

Figure 6-3: End-of-Lane Sublots



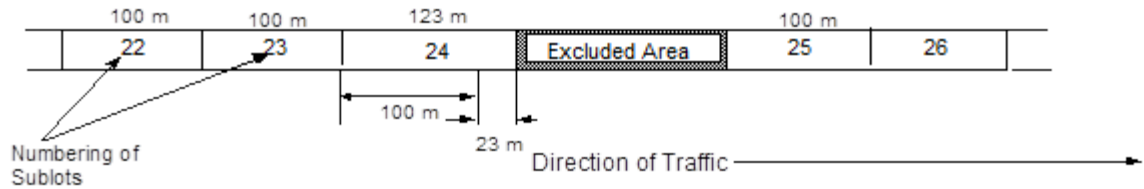
6-5.1.3 Sublots before Excluded Areas (F31)

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 subplot or a new subplot created in the same manner as described for end-of-lane sublots in section 6-5.1.2.

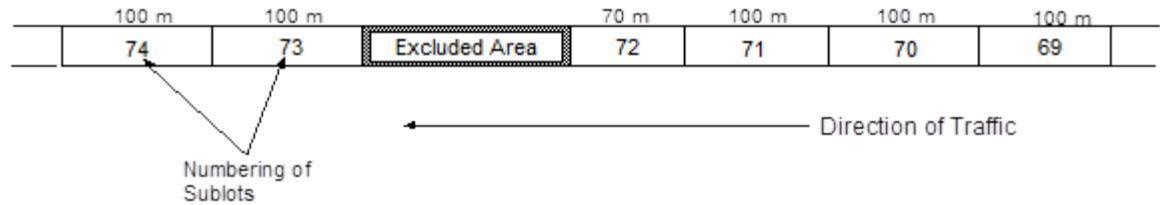
The sequential numbering of the sublots should resume after the excluded areas.

Figure 6-4: Sublots before Excluded Areas

Example: Sublot Less than 50 m Before Excluded Area



Example: Sublot Equal to or More than 50 m Before Excluded Area

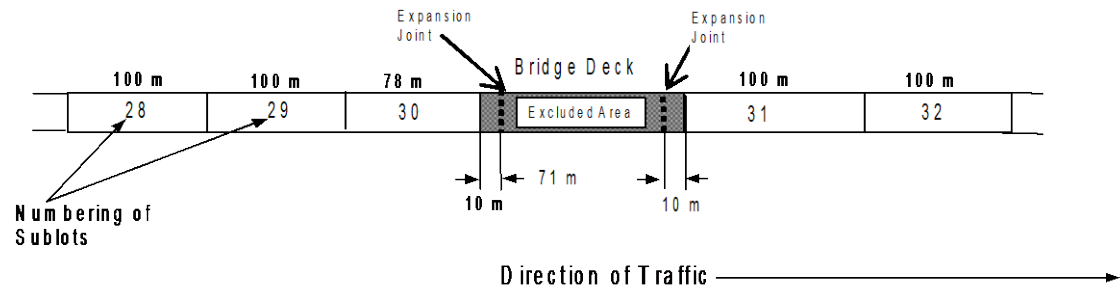


6-5.1.4 Bridge Decks (F31)

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

Example: Bridge Deck and Abutment Areas



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 subplot 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 subplot 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 subplot 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 subplot within five Business Days after receiving all the summary sheets and files. The request must identify the sublots 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 rededecisioning 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 subplot, the entire subplot 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 **the pavement treatment**, 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 subplot 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 (F03)

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 103F03 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 (F03)

7-2.1 Sampling for Lift Thickness (F03)

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 subplot (taken after all lifts are placed in a location). This single core per subplot 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 (F03)

See section 2-4.2.1 for lot and subplot 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 (F03)

7-3.1 Acceptance of Lift Thickness (F03)

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 subplot 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 (F03)

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 Payment Calculation Spreadsheet (PH-CC-868_103F03 or **Contract SP**) for determining payment factors for gradation, AC content, air voids, compaction, and VMA for square metre items.

7-4 Referee Testing for Lift Thickness (F03)

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

7-5 Repairs for Lift Thickness (F03)

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 or **SS-1HH** 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/m² (0.50 L/m²) for protection board,
- b) 0.35 kg/m² (0.35 L/m²) 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/m² (0.20 L/m²) 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 m².
2. The samples are taken at the paving site in the presence of the Contract Administrator 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 subplot.

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/m², tack coat sampling shall proceed as follows:

Example: Tack coat in lot 1 (rate of 0.35 kg/m²) to have a set of two 1-litre samples (cans) obtained from each 40,000 m² subplot.

Determine the sublots for the lot (application rate of 0.35 kg/m²) as follows:

Total Area of placement: (24425-10000) X 3.75 X 2(lanes) = 108,187.5 m²
 Length of each subplot: 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 subplot, 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:

subplot 1	0.767
subplot 2	0.241
subplot 3	0.548

Sublot 1 random # X length of subplot = Distance into subplot
 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 subplot = Distance into subplot
 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 subplot = Distance into subplot
 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 subplot. Penetration test on the residue in accordance with LS-200 shall also be performed by the QA laboratory on the diluted product for each subplot of tack coat for information purposes.

Acceptable - percent residue by distillation $\geq 27.5\%$

Accepted with payment adjustment - percent residue by distillation < 27.5 and $\geq 20\%$

Accepted with no payment for the subplot - percent residue by distillation $< 20\%$

See section 8-7 for payment adjustment calculations.

Note 8-1: Since most SS-1 or SS-1HH 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 subplot 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 subplot percent residue is < 20%, no payment shall be made for that subplot 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:

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

Where:

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

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

$$\text{Payment Reduction} = \text{Area} \times \text{Price} \times 0.5 [1.00 - \text{Product Quality Payment Factor}]$$

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} ≥ 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 m² 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

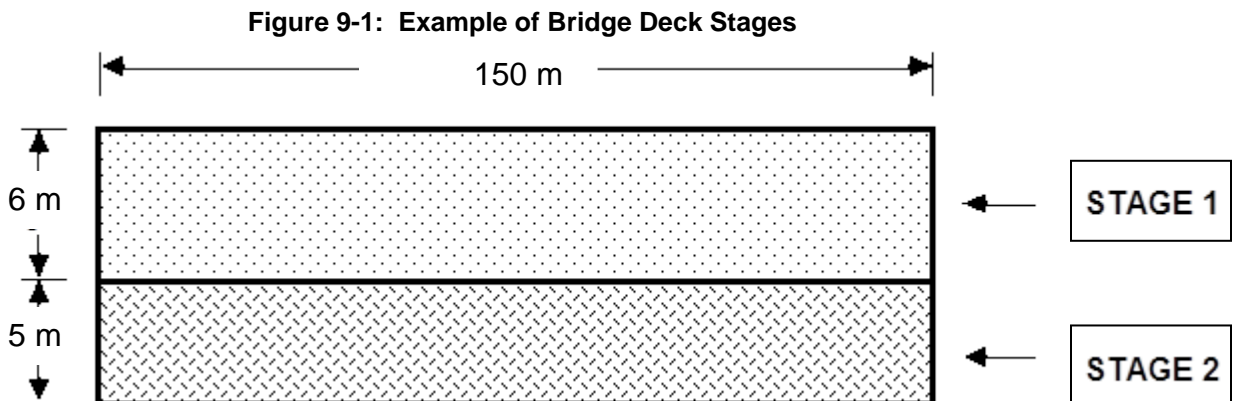
Membrane thickness acceptance procedure will be discussed by working through the following example:

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.



Step 1 Compute area of deck (by stages)

$$\begin{array}{lcl} \text{Stage 1: } 6 \times 150 & = & 900 \text{ m}^2 \\ \text{Stage 2: } 5 \times 150 & = & 750 \text{ m}^2 \\ \text{Total} & = & 1650 \text{ m}^2 \end{array}$$

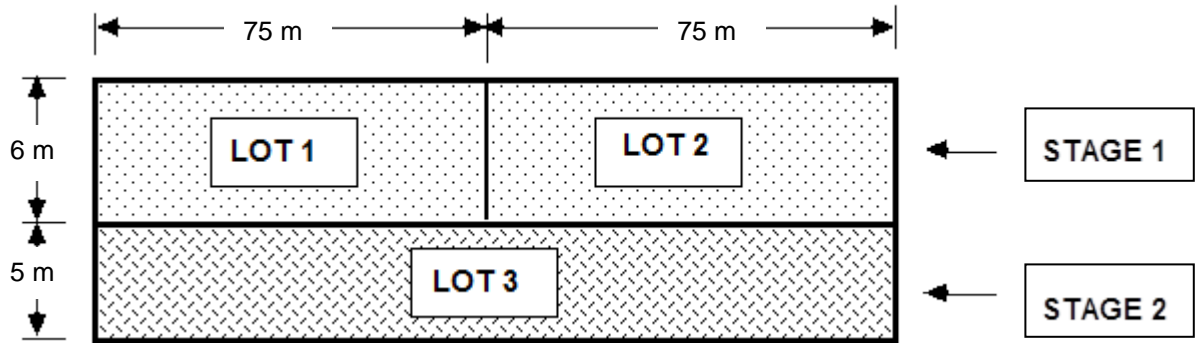
Step 2 Determine lot sizes to the closest 0.1 m² and assign lot numbers

Since the first stage will be in excess of 800 m², it must be divided into two equal lots, each 75 metres long.

The second stage, which has an area under 800 m² (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 subplot, divide the length of the lot by ten. The distance into each subplot 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

$L_s = 75 \div 10 = 7.5 \text{ m}$; Length of each subplot 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

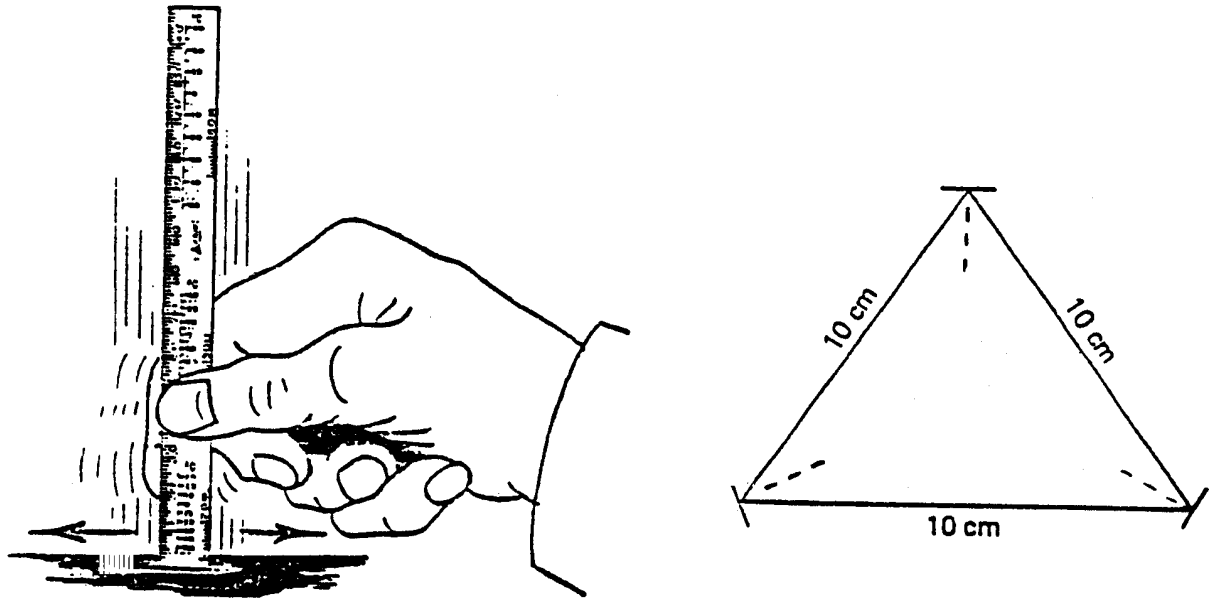
Mark out each computed test location on the deck as soon as construction of the lot is completed.

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 subplot, 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 ΣT on Form PH-CC-129A (see example filled out form in Figure 9-4).
2. Square the sum (ΣT) and record in the Sum² box ($(\Sigma T)^2$) (below the ΣT box).
3. Divide the sum (ΣT) by 10 and enter the result, accurate to one decimal place in the Mean box.
4. Square each thickness (T) and enter in the thickness² column T².
5. Add the 10 thickness² (T²) and enter in the sum of thickness² box (ΣT^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 subplot 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



Ministry of
Transportation

PROTECTION BOARD AND WATERPROOFING MEMBRANE THICKNESS REPORT REPORT No. 1 of 3

CONTRACT No. <u>2015-30XX</u>	REGION <u>West</u>	HWY. No. <u>401</u>	SITE No. <u>8-466</u>
AREA OF DECK <u>1650</u> m ²			
PROTECTION BOARD MANUFACTURER <u>Superboard</u>			
PROTECTION BOARD PRODUCT NAME <u>Superboard</u>			
MANUFACTURER'S LOT NUMBER(S) AND DATE OF MANUFACTURE FOR PROTECTION BOARD <u>Lot 68-347 (May 1, 2015)</u>			
MEMBRANE MANUFACTURER <u>Superplastic II</u> WATERPROOFING CONTRACTOR <u>Torrid Waterproofing</u>			

LOT No. <u>1</u>	OF <u>3</u>	AREA OF LOT <u>550</u>	m ²
PROTECTION BOARD THICKNESS (mm)			
	Side 1	Side 2	Side 3
Measurement 1 (mm)	3.4	4.1	3.3
Measurement 2 (mm)	3.6	3.7	3.1
Measurement 3 (mm)	3.9	3.7	3.6
Average Protection Board Thickness (average of 12 measurements of one board) (mm)			3.6

WATERPROOFING MEMBRANE THICKNESS				
<input type="checkbox"/> FIRST TEST <input type="checkbox"/> 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

$\text{St.Dev.} = \sqrt{\frac{n \cdot (\sum T^2) - (\sum T)^2}{n \cdot (n-1)}}$ $= \sqrt{\frac{10 \cdot 225 - 2209}{90}} = \sqrt{0.4555} = 0.6749 = 0.68$	Sum	$\sum T$	47	$(\sum T^2)$	225
	Sum ²		2209		
	Mean = Sum/10		4.7		

ADJUSTMENT FACTOR 1.0

THE PROTECTION BOARD THICKNESS FOR THIS LOT IS: <input type="checkbox"/> ACCEPTABLE <input type="checkbox"/> REJECTABLE	
THE WATERPROOFING MEMBRANE THICKNESS FOR THIS LOT IS: <input type="checkbox"/> ACCEPTABLE AND WILL BE PAID AT THE CONTRACT PRICE <input type="checkbox"/> MARGINAL, MAY BE LEFT IN PLACE AT THE ADJUSTED PRICE <input type="checkbox"/> REJECTABLE, IT MUST BE REPAIRED CONTRACT ADMINISTRATOR	<input type="checkbox"/> THIS LOT FALLS IN THE MARGINAL ZONE. I REQUEST THE ABOVE ADJUSTMENT FACTOR BE APPLIED TO THIS LOT. <input type="checkbox"/> I WILL REPAIR THIS LOT PRIOR TO RETESTING <input type="checkbox"/> I REQUEST RETESTING
ACKNOWLEDGED BY CONTRACTOR DATE <u>10 18 2015</u>	CONTRACTOR DATE <u>10 18 2015</u>

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 Mean															
		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	
Lot Standard Deviation	0.0															0.0	Lot Standard Deviation
	.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 Mean																	
		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			
Lot Standard Deviation	1.05	Rej	.76	.87	.94	.97	.99	.99	Acc								1.05	Lot Standard Deviation	
	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 subplot 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 subplot the sample will be taken and the second digit is used to identify how far into the subplot it will be taken.

- | | | | |
|------|------|---|---------------------------------|
| e.g. | .919 | - | 9th Sublot
10% into subplot |
| | .370 | - | 3rd Sublot
70% into subplot |
| | .024 | - | 10th Sublot
20% into subplot |

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 subplot 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 **from Manufacturer's approved list**,
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 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 the Manufacturer's approved tack coat**
- b) **For each contract, a 300 mm by 300 mm piece of the Manufacturer's approved 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.**

Step 5 Ship the samples

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 6 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. <u>2015-30XX</u> Dist/Region <u>West Region</u> Date Sampled <u>October 18/2015</u>			
Sampled By <u>CA Consulting Eng./Torrid Waterproofing</u>		Phone No. <u>905-555-2020</u>	
Field Sample No. <u>12345</u>		Results to: <u>CA@consultingeng.com</u>	
Remarks: <u>Hwy 401 – Bridge #5 Stage #1</u>			
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 <input type="checkbox"/>		Chemical (Including Superplasticizers) <input type="checkbox"/>
	Latex <input type="checkbox"/>		
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 <u>The Waterproofing Company</u>		Product Name <u>Superlastic II</u>	Batch No. <u>532469</u>
Sample Temperature <u>187°C</u>		Lot <u>1</u> of <u>3</u>	
Structure Site No. <u>8-466</u>		Applicator <u>Torrid Waterproofing</u>	
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 <input type="checkbox"/>		or available <input type="checkbox"/>	
Key Map <input type="checkbox"/>	Specimen location sketch <input type="checkbox"/>	Crack survey <input type="checkbox"/>	½ cell survey <input type="checkbox"/>
Delamination survey <input type="checkbox"/>			
Field Remarks _____			
Testing Requested:		Visual description <input type="checkbox"/>	Compressive Strength <input type="checkbox"/>
Air by linear traverse <input type="checkbox"/>	Composition <input type="checkbox"/>	Salt Scaling <input type="checkbox"/>	Absorption <input type="checkbox"/>
Petrographic exam <input type="checkbox"/>	Modulus of elasticity <input type="checkbox"/>	Chloride permeability <input type="checkbox"/>	Chloride content <input type="checkbox"/>
Other _____			Tensile Strength <input type="checkbox"/>

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

<u>Test</u>		<u>Result</u>	<u>Spec.</u>	<u>Reject</u>
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	$P5 = 500*(0.040-0.038)$	=	<u>1.0</u>
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:

$$(100 - 10.6) \div 100 = 89.4 \div 100 = 0.894$$

See the example of a field sample test report form on the following page.

Step 7 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/m².

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	= <u>\$11,465.55</u>
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: 3521-2

HOT APPLIED RUBBERIZED ASPHALT WATERPROOFING MEMBRANE

<p>To: Contract Administrator West Region</p> <p>CC: Head, Quality Assurance Section</p>	<p>From: Materials Engineering & Research Office Concrete Section, Room 235 Building 'C', Downsview Complex</p> <p>Date: 06-Mar-15</p> <p>Tel:</p>
--	--

CONTRACT # 2015-30XX
 REGION West
 SITE # S-466
 LOCATION Hwy. 401
 PRODUCT Superlastic II
 APPLICATOR Torrid Waterproofing

LABORATORY # 052318
 DATE SAMPLED 10 18 2015
 DATE RECEIVED 11 22 2015
 DATE COMPLETED 02 03 2015
 FIELD # 1
 LOT # 1

TEST	SPECIFICATION LIMITS OP55 914	TEST VALUES	DIFF. OUTSIDE SPEC. LIMIT	ADJUSTMENT POINTS	TOTAL ADJUSTMENT PER TEST	REJECTION VALUE OP55 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)		> 150
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.

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:

$$\begin{array}{l} 1.1249 \times 2 = 2.2498 \quad : 2.2 / 2 = 1.10 \\ 1.1250 \times 2 = 2.2500 \quad : 2.3 / 2 = 1.15 \\ 1.125 \times 2 = 2.250 \quad : 2.3 / 2 = 1.15 \\ 1.126 \times 2 = 2.252 \quad : 2.3 / 2 = 1.15 \end{array}$$

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 (\bar{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:

$$Q_L = \frac{\bar{X} - LL}{s} \quad Q_U = \frac{UL - \bar{X}}{s}$$

where:

Q_L	=	Lower Quality Index Value
Q_U	=	Upper Quality Index Value
LL	=	Lower Specification Limit
UL	=	Upper Specification Limit
\bar{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 (\bar{X}) = 35.4 Lower Specification Limit (LL) = 30
Standard Deviation (s) = 3.22 Number of Test Results (n) = 42

$$Q_L = \frac{\bar{X} - LL}{s} = \frac{35.4 - 30}{3.22}$$

$$Q_L = 1.68$$

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).

$$\begin{aligned} PWL &= (P_L + P_U) - 100 \\ &= (96 + 100) - 100 \\ &= 96 \end{aligned}$$

6.2 Mean (\bar{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

$$Q_L = \frac{\bar{X} - LL}{s} = \frac{95.3 - 91.5}{2.87}$$

$$Q_U = \frac{UL - \bar{X}}{s} = \frac{97.0 - 95.3}{2.87}$$

$$Q_L = 1.32$$

$$Q_U = 0.59$$

From Table 1: $P_L = 91$
 $P_U = 72$

$$\begin{aligned} PWL &= (P_L + P_U) - 100 \\ &= (91 + 72) - 100 \\ &= 63 \end{aligned}$$

6.3 Mean (\bar{X}) = 222.4
Standard Deviation (s) = 8.72

Upper Specification Limit (UL) = 220
Number of Test Results (n) = 61

$$Q_U = \frac{UL - \bar{X}}{s} = \frac{220 - 222.4}{8.72}$$

$$Q_U = -0.28$$

From Table 1, a Q_i of 0.28 gives a P_i of 61, however, as Q_U is negative.

$$P_U = 100 - 61 = 39$$

$$P_L = 100 \text{ (no lower limit is specified)}$$

$$\begin{aligned} PWL &= (P_L + P_U) - 100 \\ &= (100 + 39) - 100 \\ &= 39 \end{aligned}$$

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 left 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 subplot 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

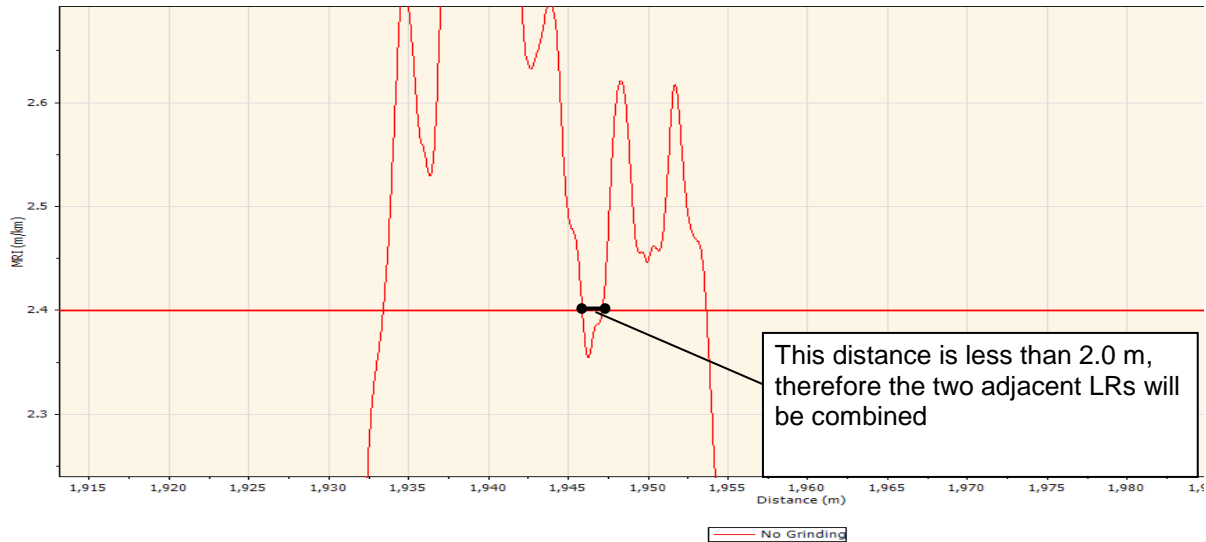
- 1) Go to **Analysis** at the top of the screen and pick **Power Spectral Density** from the drop-down menu.
- 2) Left click the **LElev** for first file. This was the unfiltered file.
- 3) Set the **Filter Type** to **None**.
- 4) Make sure that **Octave Bands** is checked and **Bands per Octave** 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 LR 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 LR will be combined as explained below.



Original ProVAL report for the above two LR's 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 LR's 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 LR 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 LR 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 LR that are within the station limits of one LR in Run 3. When this happens, the LR in Run 1 and 2 with the longer overlap with the LR in Run 3 are placed in the same row. The other LR 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)	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



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