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1.1 TESTING AND EVALUATION OF FINISHED PAVEMENT SURFACE SMOOTHNESS USING INTERNATIONAL ROUGHNESS INDEX (IRI) CRITERIA

1.1.1 General

Contrary to the requirements of Specification 3.50, Asphalt Concrete Pavement - EPS, of the Standard Specifications for Highway Construction, testing and evaluation of the finished pavement surface for smoothness shall be carried out using International Roughness Index (IRI) criteria.

Using a high speed Inertial Profiler (IP), the Contractor shall carry out this work in accordance with the following Provisions and as directed by the Consultant.

Smoothness testing shall be carried out by firms which are currently pre-qualified by the Department in the category of QA Pavement Smoothness - Inertial Profiler.

Unless previously approved by the Consultant, smoothness testing shall be carried out only in the presence of the Consultant at a mutually agreed upon schedule. Smoothness tests carried out without the Consultant present shall be re-done by the Contractor at his expense.

The smoothness evaluation shall consist of an assessment for Ride Quality and an assessment for Areas of Localized Roughness (ALR).

The Contractor shall use the most recent version of the FHWA Profile Viewing and Analysis software program (ProVAL) to conduct a profile analysis to determine Ride Quality and ALR. The ProVAL software and user's guide are downloadable, free of charge, from **www.roadprofile.com**.

IRI values shall be reported in units of m/km and expressed to the nearest 0.01 m/km using conventional rounding procedures.

The Ride Quality assessment shall be on a 0.1 km sublot basis and shall use the Mean IRI (MIRI) as being the average of the left and right wheel path IRI values. The Ride Quality module in ProVAL is located within the Analysis tab.

Assessment for ALR will be completed using the short continuous analysis within the Smoothness Assurance module of ProVAL. Analysis will involve a continuous IRI calculation in the right wheel path only using a moving base-length of 7.62 m.

1.1.2 Equipment Requirements

The high speed IP shall meet the requirements of ASTM E 950 Class I equipment, and shall be calibrated to the Manufacturer's recommendations. Prior to being used on each project, the horizontal and vertical calibrations for the equipment shall be verified using the Manufacturer's recommended procedures. Documented verification shall be provided to the Consultant upon

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request.

IP equipment shall be capable of measuring the profiles of two wheel paths simultaneously during a single pass, at a minimum sampling frequency of 16 kHz. The sampling interval shall be less than or equal to 25.4 mm, and the accelerometer shall have a minimum range of ± 2.5 g. The spacing between laser sensors shall be 1.75 m.

The high speed IP shall contain an automated triggering system capable of detecting reference marks to start, stop and event mark the data collection process. Profiler equipment shall include an onboard computer system capable of storing all profiler measurement data, calculating the real time International Roughness Index as per ASTM E1926, and displaying profile plots. The equipment shall be capable of exporting raw profile data in unfiltered electronic Pavement Profile File standard (.ppf) format.

1.1.3 Areas Excluded for Assessment or Testing

1.1.3.1 General

Inertial profiler testing and smoothness assessment shall be carried out on all main alignment lanes, interchange ramps, passing, climbing, deceleration and acceleration lanes subject to the following exclusions.

1.1.3.2 Excluded Assessment Areas

The following main alignment lanes and interchange ramps shall be tested, profile analyzed and assessed for ALR but are excluded from Ride Quality assessment:

- Pavements with a posted speed limit of less than 70 km/h.

The following main alignment lanes shall be tested and profile analyzed but are excluded from bonus/penalty assessments for Ride Quality and ALR:

- Portions of pavement which are within 10 m of obstructions such as manholes, water valves or other embedded hardware.
- Pavements that are within an approach distance of 15 m from the junction between pavement and bridge decks, bridge approach panels and railway tracks, or 30 m after leaving in the direction of travel.
- Horizontal curves with a radius of less than 340 m.
- Portions of pavement where testing was undertaken at speeds of less than 20 km/h due to the inertial profiler starting from or coming to a Stop sign condition.
- *(Identify other areas of exclusion, if applicable)* **– Delete Bullet if N/A**

Areas of Localized Roughness excluded from bonus/penalty assessments may be subject to remedial work at the discretion of the Consultant.

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1.1.3.3 Excluded Testing Areas

The following lanes are excluded from profile testing:

- Ramps; and acceleration and deceleration lanes less than 300 m in length.
- Loops, turn lanes, storage lanes, tapers and median crossovers.
- Pavements with a posted speed limit of less than 60 km/h.

Areas excluded from profile testing may be evaluated by the Consultant using a 3.0 m straightedge placed in any direction and at any location within the travel lane. Pavement surfaces shall show no variation greater than 6.0 mm from the edge of the 3.0 m straightedge, excluding deviations due to crown breaks at locations shown on the Drawings.

1.1.3.4 Sublot Adjustment

Sublots that are less than 100 m but greater than 50 m in length, will be assessed for Ride Quality on a pro-rated basis. Sublots that are 50 m or less in length will not be assessed for Ride Quality but will be assessed for ALR.

1.1.4 Pavement Surface Testing

The Contractor shall remove all objects and foreign material on the pavement surface by hand or power brooming, as necessary, prior to smoothness testing.

Prior to testing, the Contractor shall obtain the kilometre limits for testing, including limits for the excluded testing and assessment areas as described herein, from the Consultant.

The profiler operator shall operate the IP within the optimum speed range as recommended by the Manufacturer. The IP shall be operated in the direction of traffic only. Longitudinal profiles shall be measured within the left and right wheel paths of the lane. Each lane shall be tested and evaluated separately.

Each pass shall be carried out in an uninterrupted, continuous run; and shall include areas excluded for smoothness assessment. Notwithstanding this requirement, the Contractor may test portions of the work completed prior to the full project completion.

The profiler operator will be permitted to make up to three individual passes, and will be allowed to choose which single pass is submitted and used for smoothness acceptance and assessment purposes.

Sublots and the assessment for Ride Quality and ALR shall begin 10 m onto the new ACP and end 10 m before the end of the new ACP.

Sublots or ALR identified as reject shall be jointly inspected by the Consultant and Contractor prior to undertaking remedial work.

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Smoothness testing and profile analysis of intermediate lifts will not be required, but may be completed by the Contractor if desired. Payment assessments for sublot Ride Quality and ALR will not apply to intermediate lifts. No payment will be made for smoothness testing of intermediate lifts carried out by the Contractor.

1.1.5 Report Submission Requirements

1.1.5.1 Day of Profiling

The Contractor shall submit the following to the Consultant on the day of profiling:

- A printout containing the inertial profiler's settings.
- IRI values for each wheel path on a sublot basis.
- An electronic copy of the raw unfiltered profile data in .ppf or .erd format.

Hard copy documentation noted above shall be signed by the IP operator.

1.1.5.2 ProVAL Summary Reports

The Contractor shall submit ProVAL summary reports in .pdf format for each lane indicating the results of the Ride Quality and Smoothness Assurance analyses to the Consultant within five days of initial profiling, and after re-profiling following corrective repairs where required. Units of measure to be used within ProVAL shall be mm for elevation and kilometres for distance. Testing and report stationing shall match the Alberta Transportation linear reference system.

The inputs for the Ride Quality analyses shall include the Fixed Interval option with a base line length of 100 m (0.1 km) and shall include both wheel paths. All analyses shall apply the 250 mm filter. The Ride Quality report shall be generated in .pdf format by the ProVAL software.

The Contractor shall indentify ALR using the Smoothness Assurance analysis by calculating the IRI with a continuous short interval of 7.62 m using the right wheel path profile with the 250 mm filter selected and an IRI limiting value of 2.75 m/km. A Continuous Short Interval report shall be provided for each lane listing the km limits and length for all ALR in excess of the limiting IRI. Portions of ALR which are to be excluded from assessment as noted herein shall be reported, but clearly identified as being excluded areas.

If no remedial work is identified by the Consultant, then this submission will be considered the Final ProVAL Report and the Contractor shall then submit the completed smoothness summary spreadsheet as outlined in the Smoothness Summary Spreadsheet Subsection.

Profiler re-testing shall be completed following repairs for rejected sublots or corrective work done on ALR. The Contractor shall submit the final ProVAL reports for Ride Quality and Smoothness Assurance, as applicable, and the Smoothness Summary Spreadsheet to the Consultant within five days of completing the repairs. An electronic copy of the raw unfiltered profile data shall also be provided for the re-tested areas.

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1.1.5.3 Smoothness Summary Spreadsheet

The Contractor shall provide Ride Quality and ALR data in EXCEL format spreadsheets provided by the Department for the purpose of determining bonus/penalty assessments. The header information shall include the following as a minimum:

- Contract number.
- Highway number and control section.
- Contractor name.
- IP operator
- Smoothness testing firm name.
- Lane number and direction.

IRI data for Ride Quality shall be reported for each wheel path on a 0.1 km basis. Sublots and ALR which are to be excluded for assessment shall be identified as such in the Excluded Areas column, with remarks provided in the Comments section detailing the reason(s) for exclusion.

1.1.6 Inspection and Repairs for Rejected Work

The pavement limits for ALR, as identified in the ProVAL reports, may be marked in the field by the Contractor. Prior to undertaking repairs, the ALR and sublots indentified as reject for Ride Quality may be jointly inspected by the Consultant and the Contractor.

Sublots identified as reject and/or Individual sites of ALR may be accepted by the Consultant at his discretion after driving these areas to evaluate the ride.

When repairs for rejected sublots and ALR are required, they shall be in accordance with Subsection 3.50.6.2, End Product Acceptance, of Standard Specification 3.50, Asphalt Concrete Pavement - EPS. Upon approval by the Consultant, corrective work may be carried out using a surface diamond grinding device consisting of multiple diamond blades. When directed by the Consultant, pavement surfaces that have been diamond ground shall be fog coated. All costs associated with the supply and application of fog coat, if required, will be considered incidental to the Work, and no separate or additional payment will be made.

All sublots with repaired areas shall be re-tested and profile analyzed by the Contractor. The results of the re-tested sublots shall be included in the ProVAL Summary Reports and Smoothness Summary spreadsheet provided to the Consultant.

1.1.7 Assessments for Ride Quality and Areas of Localized Roughness

1.1.7.1 General

Pavement smoothness will be assessed using MIRI criteria for Ride Quality and IRI criteria for Areas of Localized Roughness in accordance with the following.

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1.1.7.2 Ride Quality

The assessment for ride quality will be on a sublot basis as outlined in Table 3.50 C1 and according to the type of construction as outlined in Table 3.50 C2.

Table 3.50 C1

LUMP SUM SUBLOT ASSESSMENT FOR RIDE QUALITY

MIRI (m/km) Average of left and right wheel paths Assessment for Ride Quality of Top Lift ($ per Sublot)	**ASSESSMENT FOR RIDE QUALITY**		
	S I	**S II**	**S III**
<0.55	50	50	50
0.55 - 0.70	30	30	30
0.71 - 0.80	0	30	30
0.81 - 1.04	0	0	0
1.05 - 1.20	740 - (740 x MIRI)	0	0
1.21 - 1.54	740 - (740 x MIRI)	1090 - (930 x MIRI)	0
1.55 - 1.85	Reject (1)	Reject (1)	740 - (490x MIRI)
>1.85	Reject(1)	Reject (1)	Reject (1)

(1) Sublot may be accepted without corrective work, subject to the approval of the Consultant, with an assessment of -$500.

Ride Quality and ALR will be assessed based upon the type of construction as follows.

Table 3.50 C2

TYPE OF CONSTRUCTION FOR SMOOTHNESS ASSESSMENTS

TYPE OF CONSTRUCTION	**TABLE 3.50 C1 ASSESSMENT COLUMN**
Two or more paver laid lifts, minimum design lift thickness of 20 mm	S I
Mill full pavement width or re-profile by cold milling full pavement width; followed with one or more paver laid lifts	S I

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TYPE OF CONSTRUCTION	TABLE 3.50 C1 ASSESSMENT COLUMN
greater than or equal to 45 mm	
Mill and inlay of entire lane; followed with one or more paver laid lifts greater than or equal to 45 mm	S I
Mill full pavement width or re-profile by cold milling full pavement width; followed with one paver laid lift of less than 45 mm	S II
All pavement with a posted speed limit less than 70 km/h	ALR assessment only (S II)
Single lift with design lift thickness greater than or equal to 45 mm	S II
Hot In-Place Recycling or Mill and Inlay	S III
Curb and Gutter	S III
Single Lift with design lift thickness less than 45 mm	S III

1.1.7.3 Areas of Localized Roughness

Areas of Localized Roughness will be measured on a per metre basis as calculated through the ProVAL Smoothness Assurance analysis. Payment reduction for ALR will be $15.00 per metre for S II and S III construction, and $40.00 per metre for S I construction. Payment reduction for ALR will be based upon the initial inertial profiler test results; however, sites of ALR which have been repaired and re-tested by the Contractor with results indicating that the short continuous roughness is less than 2.75 m/km will not be subject to a payment reduction.

1.1.8 Department Verification Testing

The Contractor is advised that the Department may carry out independent verification testing on the entire project or portions of the project at any time. Verification testing and profile analysis by the Department will be carried out in accordance the procedures described in these Provisions. If verification testing by the Department is to occur, the Consultant will provide the Contractor with a minimum of 48 hrs. advance notice in order to provide the Contractor an opportunity to witness the testing.

If the verification testing indicates that the MIRI value of the re-tested sublots differs by no more than 10% from the original results, then the Contractor's results will be considered acceptable. If the MIRI value of the re-tested sublots differs by more than 10%, then the Consultant and Contractor shall review all aspects of the smoothness testing, both quality control and verification, to determine a solution that is mutually agreeable to the Contractor and the Department. If a mutually agreeable solution is not achievable, and the resulting dispute could

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result in incorporating nonconforming pavement, the Department will use third party testing for resolution of a dispute. The results of the third party testing will be binding, and will be used to determine product acceptance and payment assessments.

1.1.9 Payment

1.1.9.1 Contractor Testing

All costs associated with pavement smoothness testing, data analysis and report submissions; including the re-testing of repaired sublots or areas of localized roughness, will be considered incidental to the Work, and no separate or additional payment will be made.

1.1.9.2 Verification and Third Party Testing

All costs associated with verification testing will be the responsibility of the Department.

In the event that third party testing is required, costs associated with this testing will be assigned in accordance with the following:

- If the results from this testing match more closely to the verification test results obtained by the Department, the Contractor will be invoiced for all costs associated with the third party testing.

- If the results from this testing match more closely to the original test results obtained by the Contractor, the Department will assume all costs associated with the third party testing.