MEASUREMENT PROCEDURES FOR A CALIBRATION COURSE

Prepared by:

The Road Course Measurement and Certification Sub-Committee

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August 1, 1984

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A calibration course can be measured accurately in two ways: A) by a land surveyor using an Electronic Measuring Device or B) by a team of measurers using a certified steel tape.

A. STEEL TAPE MEASUREMENT OF A CALIBRATION COURSE

1. Gather the necessary measuring equipment:

- a certified steel tape, on a reel, 30 metres minimum (we find 50 metres easier to use). You could also use a certified 100 ft. steel tape. You could get your tape certified by the National Research Council or ask your local land surveyor. FIBER TAPES ARE NOT ACCEPTABLE.
- a tension handle (A brand recognized as being a precision instrument)
- security vests or outfits (bright orange)
- safety glasses or goggles (to be used while hammering in nails)
- red safety flags or "STOP" signs
- crayons or pens to write on the ground
- cement nails with washers or even better P.K. nails (Parker-Kalon)
- a calculator (or two) with extra batteries
- A clamphandle, if needed
- a hammer
- a thermometer
- a compass
- a chisel (to make hole to put nail)
- fluorescent paint
- a notebook and pencil
- a tension handle or a good fish scale.
- masking tape

2. Gather the necessary personnel:

A minimum of three measurers (one leader, and two helpers). The leader, who also acts as the recorder, keeps the notebook and records the names of the persons in the measuring party, their adresses, age, telephone number, along with the date, temperature on the ground, the wind velocity and direction. For your safety, it is better to have more than three measurers. The leader should preferably have some experience in measuring with steel tapes.

3. Identify, a flat, straight, paved, road of at least 1 kilometre long, one which has little traffic, and has preferably few intersections. This road should be as close as possible to the start or end of the race course.

We recommend you use either an exact one kilometre or exact half mile or mile calibration course. This will facilitate the work and it lessens the chance of mistakes being made while making conversions. NOTE: In this document we use the example of a one kilometre calibration course.

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4. Draw a temporary cross on the ground where you will start measuring the first kilometre.

5. Put the tension handle at the 0 end of the tape

6. The leader explains the measuring procedures that will be used. The helper that holds the tape at the zero end of the tape is called "tension man".
The man that holds the end of the tape is called "tailman". The leader supervises and records. The leader makes a check to determine the proper 0 at the end of the tape.

   The leader shows where to read the zero on the tape; explains how to use the tension handle and what tension to hold; shows how to hold the tape flat and straight on the ground; teaches how each tape increment is to be written on the ground and reminds everyone of the safety practices. He takes note of the time the first measurement started.

7. Measure 1,000.000 metres (1 KILOMETRE).
Use 9 kg (20 lbs) tension on a 50 metres tape (4.5 kg or 10 lbs on a 30 metres tape). Read and take note of the temperature on the measuring surface (thermometer shaded for 5 minutes). Make sure tape is flat and straight by shaking it up and down.
Hold the end of the tape at the cross drawn on the ground and indicate the other end (0 end) with an arrow. Indicate and circle each measuring increment on the ground. Make sure you add the correct number of increments. Take note of each increment in the notebook. (20 for a 50 metres steel tape). The tension man and tail man call out loud between themselves the number of the increment at which they are, to make sure they follow the correct order. Lift the tape between markings to protect from wear and tear.

   NOTE: It is useful, as reference points for the cyclists, to paint a dot every 50 metres or so.

8. At the end of the kilometre, <u>put your safety glasses on</u> and put a nail (or two) in the measuring surface perpendicular to the side of the road. Put the nail(s) so it is accessible to the bicycle wheel. Measure at a distance from the curb so the cyclists can ride where the kilometre was measured by steel tape. Paint a circle around the nail. Measure from the nail to curb, and at least two (preferably three) acceptable landmarks such as manhole covers, fire hydrants, lampost, corner of building, and take note with a good drawing.

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9. Start again to measure the same distance from the dot on the P.K. nail to the starting cross. Draw new lines on the ground and identify each new increment. Check the count of the increments. (Measure as per instructions in 6, 7, 8 above).
Do a third measurement starting from the first cross you drew for the start of your first measurement to the dot on your P.K. nail.
Do a fourth measurement starting from the dot on your P.K. nail to the same first cross.
When finished you will have four independent measurements between the same two points.
Take note of the temperature and time at the beginning and end of each measurement.

10. Proceed to calculating and adjusting the measures according to the precision of the measuring tape, in your notebook.

11. Calculate the average temperature for each measurement.
Adjust each measurement according to the international metal expansion formula (to be used with most steel tapes):

$$C_t = (T - T_o)\ L\ K$$

as shown in the example that follows (pages 5 and 6).

12. Calculate the adjustments in the notebook. Determine the adjusted length of the four measurements. The difference between the longest and shortest measurement must be less than 10 centimetres. If the difference is greater do another measurement. There must be four measurements within the 10 centimeter limit before it is to be considered as a possible calibration course. Take note of all measurements done and the results if more than four were needed.

Take the <u>average</u> of the four acceptable measurements to represent the distance between the cross and the P.K. nail. Now add or substract whatever distance you need from the cross to come up with an exact kilometer (1,000.000 m). Put a nail in the road to identify the new cross end of this kilometer (as in 8).
Take note of the north arrow, name of surrounding streets, roads, etc. to facilitate locating the standard kilometre, a legend (if necessary).

<u>See attached drawing.</u>

NOTE: For security purposes, always insist on measuring with adults, 18 years old and over.

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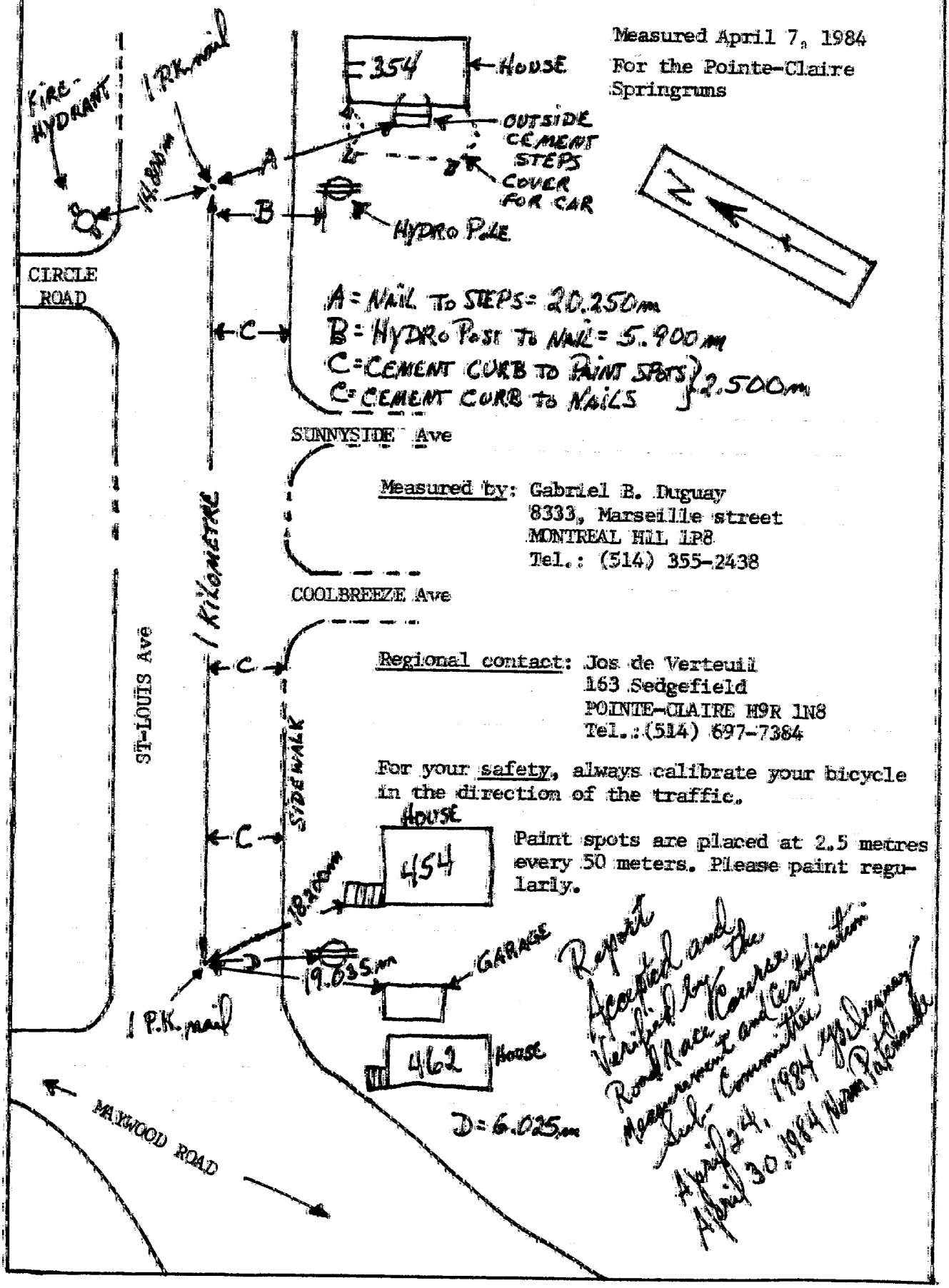
POINTE- CLAIRE (Montreal Island)

LOCATION OF A ONE KILOMETRE CALIBRATION COURSE



B. ELECTRONIC DISTANCE MEASURING (EDM) DEVICES

Measurement of the road calibration course by an EDM device is acceptable, as long as the work is performed by a land surveyor and the land surveyor supplies the Sub-Committee with a measuring report and a distance certificate. The report should indicate which EDM device was used, the date the device was last calibrated, the date(s) the measurements were performed, the measurements performed, as well as the usual sketches, (see Calibration Course Measuring Report) the adjustments performed to bring the measured distance to the desired distance. (Desired distance is usually 1,000.000 metres.)

STEEL TAPE TEMPERATURE ADJUSTMENT

When measuring a calibration course with a steel tape, an adjustment for the day's temperature must be performed. If the required adjustments for temperature are not supplied with the steel tape, we can assume that the international steel expansion formula applies to the certified steel tape.

$$C_t = (T - T_o)\ L\ K$$

C_t = Adjustment for the length of the steel tape

T = Temperature while performing the course measurement

T_o = Calibration temperature of 20°C

L = length of the steel tape

K = Expansion constant for centigrade temperatures = 0.0000118

All steel tapes are manufactured and calibrated at 20°C. At colder temperatures the tape shortens and at higher temperatures the tape expands.

Example:

You go out and measure, with your hypothetical 50 metres certified steel tape, a one kilometre calibration course in March. The temperature indicates 5°C from point A to point B. You put nails at both ends because you don't have time to make temperature adjustments or to measure your kilometre a second time that day. You come back in April and with the same steel tape you measure another kilometre, from point A towards point B. The temperature indicates 30°C and when you have laid down your tape twenty times you end up 31 centimetres past your B nail.

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You calculate your March measurement adjustment as being:

$C_t = (5^oC - 20^oC)\ 50 \times 0.0000118$

$C_t = - 0.00885$

For 20 lengths of tape for one kilometre, this give you a total adjustment of:

$20 \times - 0.00885 = - 0.177$ metres

You figure the kilometre you measured in March (20 lengths of tape) was really:

999.823 metres

You calculate your April measurement adjustment as being:

$C_t = (30^oC - 20^oC)\ 50 \times 0.0000118$

$C_t = + 0.0059$

For twenty lengths of tape, this gives you a total adjustment of:

$20 \times + 0.0059 = + 0.118$ metres

You figure your April measurement (20 lengths of tape) is actually:

1,000.118 metres

You want to compare the two measurements on a kilometre basis. You add 17.7 centimetres to your first measurement and you substract 11.8 centimetres from your April measurement.

Now you see that your adjusted April measurement is only 1.5 centimetres longer than your adjusted March measurement, well within the 10 centimetres acceptable limit. You average your two kilometre measurements and you take out the nail you had pounded in the road in March and relocate it 18.45 centimetres farther than where it was. The nail is also located 12.55 centimeters short of the end of the April measurement.

NOTE: This is only an example in which calculations were done in one way only.