**CIVL 2020 PLENARY – ANNEXE XXX**
**SOFTWARE WORKING GROUP PROPOSAL — CHANGES TO SECTION 7F**
**VERSION 0.4**

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1. Fix error in time points reduction formula in stopped tasks with multiple start gates
2. Clarification of order in which penalties are applied
3. Start the Leading Coefficient graph used for leading points calculation at task start time

# 2   Explanations

## 2.1   Fix error in time points reduction formula in stopped tasks with multiple start gates

The formula introduced in 2020 that reduces time points in stopped task can produce wrong results (square root of a negative number) in the case of a race with multiple start gates or an elapsed time task. We propose a small change that will remove this problem.

## 2.2   Clarification of order in which penalties are applied

We have three categories of penalties in hang-gliding competitions, and two categories in paragliding competitions. We specify in which order they are applied.

## 2.3   Start the Leading Coefficient graph used for leading points calculation at task start time

Right now, the start of the Leading Coefficient (LC) graph used for leading points calculation is defined as the first start by any pilot. To determine this time while a race is running, which is needed to provide accurate live scoring, is complicated and slow. We therefore propose a small change, to start the graph at the start time as set by the task setters. This makes on-the-fly calculation of leading points much easier. The slight disadvantage is a slightly compressed leading points distribution if all pilots take the start a long time after the official start time.

# 3   Changes in Detail

## 3.1   12.3.5 Time points for pilots at or after ESS

### 3.1.1   Status quo

$TypeOfTask \neq RaceToGoal \lor numberOfStartGates > 1$:
$timePointsReduction = timePoints(\, taskStopTime - max(\, \forall p\colon p$
$\in StartedPilots\colon startTime_p))$

### 3.1.2   Proposal

$TypeOfTask \neq RaceToGoal \lor numberOfStartGates > 1$:
$timePointsReduction = timePoints(\, taskStopTime - max(\, \forall p\colon p$
$\in PilotsReachedGoal\colon startTime_p))$

### 3.1.3   Reasoning

In races with multiple start gates, and elapsed time tasks, only consider pilots who reached goal to determine the time window for which no time points are handed out.

## 3.2   12.4 Penalties

### 3.2.1   Status quo

> ⍫   These penalties are completely independent of any "Jump the Gun"-Penalty a pilot may have incurred.

### 3.2.2   Proposal

If a pilot incurs multiple penalties or bonuses, these are applied in the following order:

1. "Jump the Gun"-Penalty
2. Percentage penalty or bonus
3. Absolute points penalty or bonus

1. Percentage penalty or bonus
2. Absolute points penalty or bonus

### 3.2.3   Reasoning

Specify exactly the order in which penalties are applied.

## 3.3   11.3.1 Leading coefficient

### 3.3.1   Status quo

Each started pilot's track log is used to calculate the leading coefficient (LC), by calculating the area underneath a graph defined by each track point's time, and the distance to ESS at that time. The times used for this calculation are given in seconds from the moment when the first pilot crossed SSS, to the time when the last pilot reached ESS. For pilots who land out after the last pilot reached ESS, the calculation keeps going until they land. The distances used for the LC calculation are given in kilometers and are the distance from each point's position to ESS, starting from SSS, but never more than any previously reached distance. This means that the graph never "goes back": even if the pilot flies away from goal for a while, the corresponding points in the graph will use the previously reached best distance towards ESS.

Calculation of the leading coefficient (LC) for each pilot follows this formula:

$$LC_p = \frac{\sum\limits_{i:tp_i \in TrackPointsInSS_p} \text{taskTime}(tp_i) * (\text{bestDistToESS}(tp_{i-1})^2 - \text{bestDistToESS}(tp_i)^2)}{1800 * LengthOfSpeedSection^2}$$

$$\forall p : p \in PilotsLandedOut \wedge \text{taskTime}(tp_{\max}) < ESSTime_{LastPilotAtESS} :$$

$$LC_p = LC_p + LastTime_{LastPilotAtESS} * \text{bestDistToESS}(tp_{\max})^2$$

$$\forall p : p \in PilotsLandedOut \wedge \text{taskTime}(tp_{\max}) \geq ESSTime_{LastPilotAtESS} :$$

$$LC_p = LC_p + \text{taskTime}(tp_{\max}) * \text{bestDistToESS}(tp_{\max})^2$$

$$\text{taskTime}(tp) = \min(TaskDeadline, \text{time}(tp))$$

$$\text{bestDistToESS}(tp_0) = LengthOfSpeedSection$$

$$\forall i : i > 0 \wedge tp_i \in TrackPointsInSS_p :$$

$$\text{bestDistToESS}(tp_i) = \min(\text{bestDistToESS}(tp_{i-1}), LenghtOfSpeedSection - \text{distanceFlown}(tp_i))$$
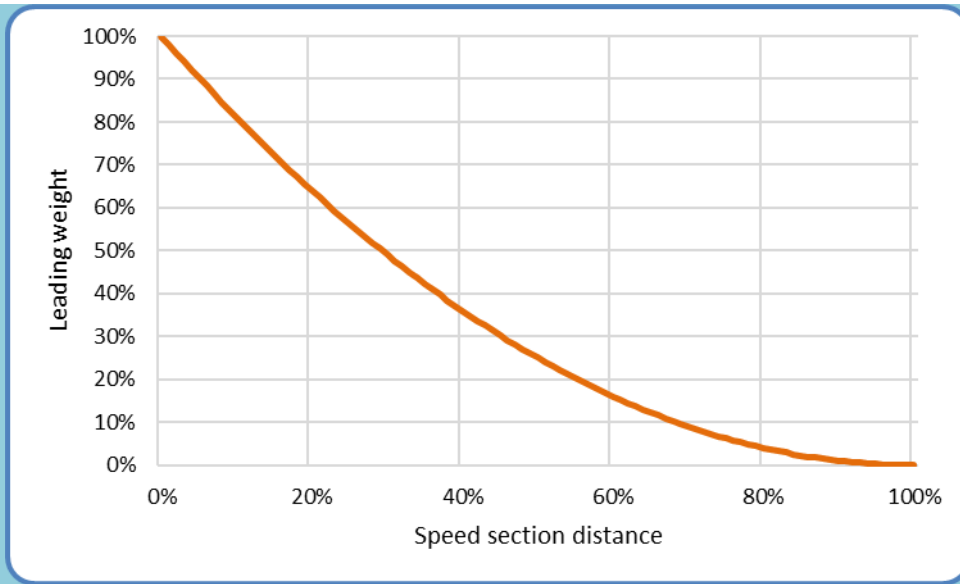
**Figure 1: Implicit leading weight for hang-gliding**

$leadingArea_p = \sum_{i:tp_i \in trackPointsInSS_p} \text{weight}(\text{minToESS}(tp_i)) * (\text{taskTime}(tp_i) - \text{taskTime}(tp_{i-1})) * \text{minToESS}(tp_i)$

$bestTrackPoint_p = \text{trackPointWithShortestDistanceToESS}(trackPointsInSS_p)$

$missingArea_p = \text{weightFalling}(\text{distToEss}(bestTrackPoint_p)) * (maxTime - bestTrackPoint_p.time) * \text{distToESS}(bestTrackPoint_p)$

$LC_p = \dfrac{leadingArea_p + missingArea_p}{1800 * speedSectionDistance}$

$\text{weight}(missingDistance) = \text{weightRising}(missingDistance) * \text{weightFalling}(missingDistance)$

$\text{weightRising}(missingDistance) = (1 - 10^{9 * \frac{missingDistance}{speedSectionDistance} - 9})^5$

$\text{weightFalling}(missingDistance) = \left(1 - 10^{-3 * \frac{missingDistance}{speedSectionDistance}}\right)^2$

$\text{minToESS}(tp_0) = speedSectionDistance$

$\forall i: i > 0, tp_i \in trackPointsInSS_p: \text{minToESS}(tp_i) = \min(\text{minToESS}(tp_{i-1}), \text{distToESS}(tp_i))$

$\text{taskTime}(trackPoint) = \min(trackpoint.time, taskDeadline)$

$maxTime = \min(\max(lastOutlandingTime, lastESStime), taskDeadline)$
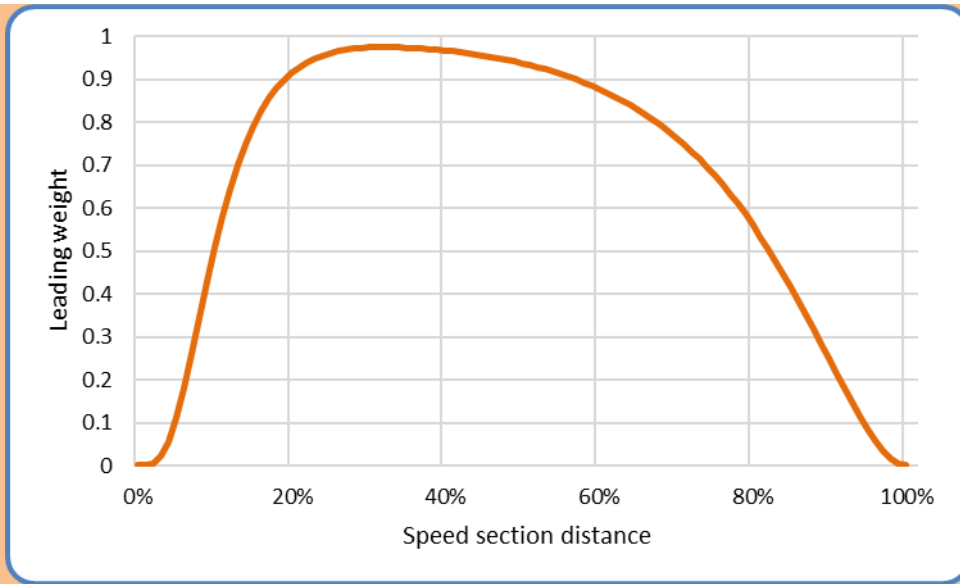
**Figure 2: Leading weight for paragliding**

### 3.3.2 Proposal

Each started pilot's track log is used to calculate the leading coefficient (LC), by calculating the area underneath a graph defined by each track point's time, and the distance to ESS at that time. The times used for this calculation are given in seconds **from the first start gate time (as defined for the task)**, to the time when the last pilot reached ESS. For pilots who land out after the last pilot reached ESS, the calculation keeps going until they land. The distances used for the LC calculation are given in kilometers and are the distance from each point's position to ESS, starting from SSS, but never more than any previously reached distance. This means that the graph never "goes back": even if the pilot flies away from goal for a while, the corresponding points in the graph will use the previously reached best distance towards ESS.

Calculation of the leading coefficient (LC) for each pilot follows this formula:

- $leadingArea_p = \sum_{i:tp_i \in trackPointsInSS_p}\big(\text{taskTime}(tp_i) - \text{taskTime}(tp_{i-1})\big) * \text{minToESS}(tp_i)$

- $bestTrackPoint_p = \text{trackPointWithShortestDistanceToESS}(trackPointsInSS_p)$

- $missingArea_p = \big(maxTime - bestTrackPoint_p.time\big) * \text{distToESS}\big(bestTrackPoint_p\big)$

- $LC_p = \dfrac{leadingArea_p + missingArea_p}{1800 * speedSectionDistance}$

- $\text{minToESS}(tp_0) = speedSectionDistance$

- $\forall i: i > 0, tp_i \in trackPointsInSS_p: \text{minToESS}(tp_i) = \min\big(\text{minToESS}(tp_{i-1}), \text{distToESS}(tp_i)\big)$

- $\text{taskTime}(trackPoint) = \min(trackpoint.time, taskDeadline) - firstTaskStartTime$

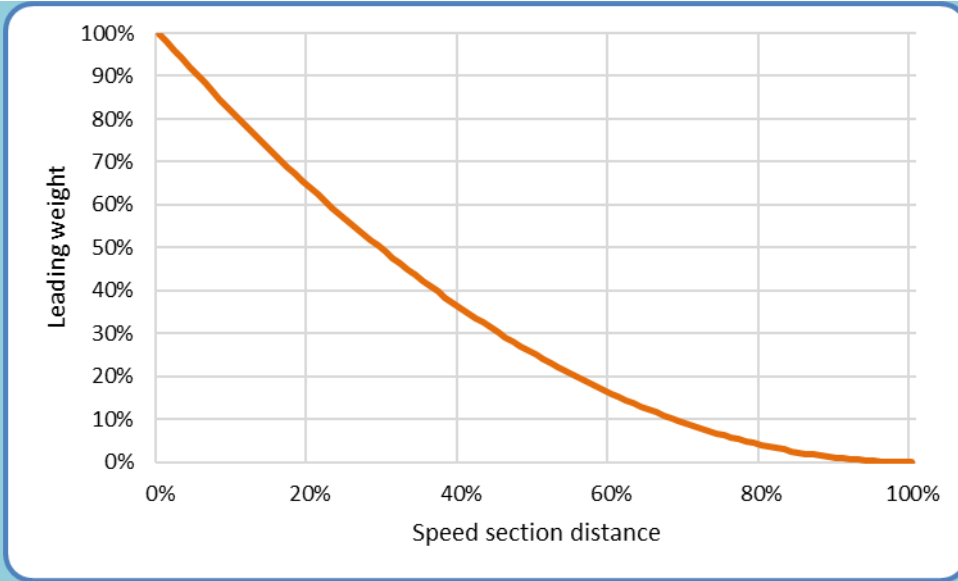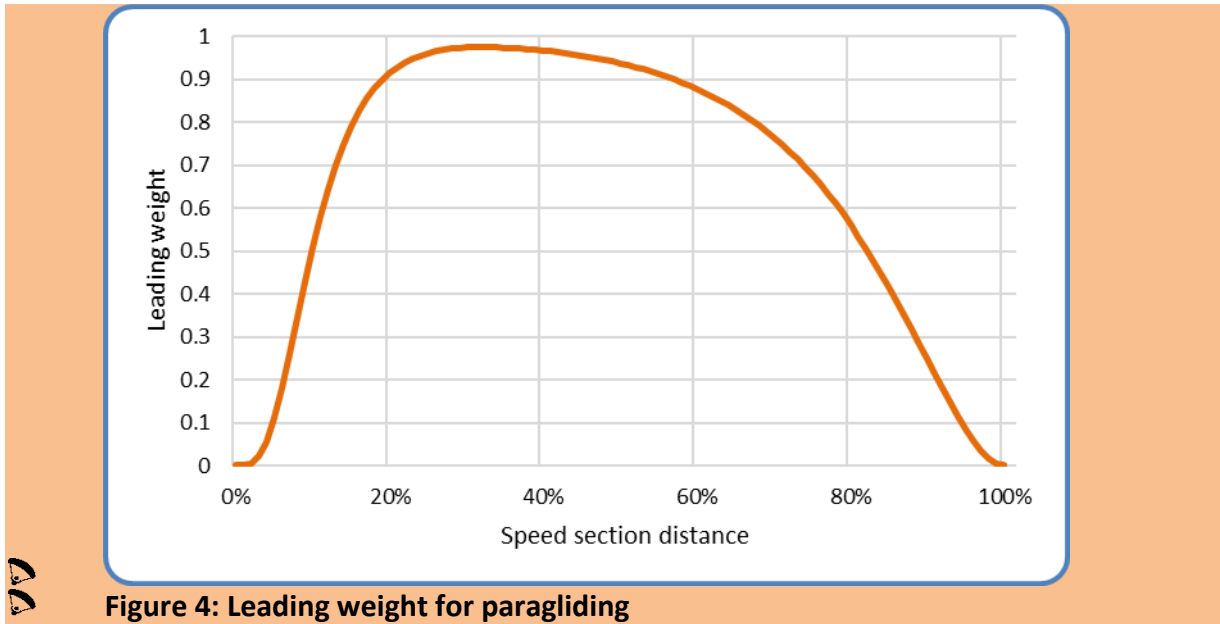- $maxTime = \min(\max(lastOutlandingTime, lastESStime), taskDeadline)$

**Figure 3: Implicit leading weight for hang-gliding**

$leadingArea_p = \sum_{i:tp_i \in trackPointsInSS_p} weight(minToESS(tp_i)) * \left(taskTime(tp_i) - taskTime(tp_{i-1})\right) * minToESS(tp_i)$

$bestTrackPoint_p = trackPointWithShortestDistanceToESS(trackPointsInSS_p)$

$missingArea_p = weightFalling\left(distToEss(bestTrackPoint_p)\right) * \left(maxTime - bestTrackPoint_p.time\right) * distToESS\left(bestTrackPoint_p\right)$

$LC_p = \dfrac{leadingArea_p + missingArea_p}{1800 * speedSectionDistance}$

$weight(missingDistance) = weightRising(missingDistance) * weightFalling(missingDistance)$

$weightRising(missingDistance) = (1 - 10^{9*\frac{missingDistance}{speedSectionDistance} - 9})^5$

$weightFalling(missingDistance) = \left(1 - 10^{-3*\frac{missingDistance}{speedSectionDistance}}\right)^2$

$minToESS(tp_0) = speedSectionDistance$

$\forall i: i > 0, tp_i \in trackPointsInSS_p: minToESS(tp_i) = min\left(minToESS(tp_{i-1}), distToESS(tp_i)\right)$

$taskTime(trackPoint) = min(trackpoint.time, taskDeadline) - firstTaskStartTime$

$maxTime = min(max(lastOutlandingTime, lastESStime), taskDeadline)$

**Figure 4: Leading weight for paragliding**