Lungern, 3rd June 2013

Standards for the Construction of Jumping Hills 2012
Design of jumping hills with the programs JUMP 2 1.4 and the Excel program JUMP 2 2.0

Starting position

In Winter 2010/2011 we have observed an increase in performance of the ski jumpers compared to our trajectory analysis in Engelberg 2006. We could explain this with a progress in ski jumping and with the development of the competition equipment.

This fact alone would not justify it, to revise the 2008 construction standards from scratch. It mainly relates only to the determination of the in-run lengths. Improved performance of the athletes requires a lowering of the lowest starting gate. Also the formulas for the calculation of the top starting gate, as they have been used until now, must be revised. The FIS Sub-Committee for Jumping Hills has now set new criteria for the calculation of the length of the in-run. Also new is the definition of the length of the in-run (e), where the take-off table (t) is included. These changes are recorded in the 2012 edition of the construction standards.

But these new criteria don't satisfy the implementation in simple formulas any more. The approximate formulas (specified in the new construction standards in 2012 under Section 4.1) can result in deviations from the exact values up to several meters. For this reason, it became necessary for the program **JUMP-2 1.4** which was issued in 2008 with the construction standards the use of a supplementary Excel computer program,

This **JUMP-2 2.0** program will be resupplied to the owners of the main program with the new 2012 construction standards.

New approach
Planning a ski jump profile you begin - as before - with the program JUMP-2 1.4. If the optimized profile exists, the jumping hill parameters can be taken from the calculations protocol and profile and result files can be printed. Of no use are only the values v_0, e and e_s, as well as the coordinates of the starting gates A and B.

Now the Excel program JUMP 2 2.0 is started. On request, the macro program is to activate. The parameters of the jumping hill are in cells C3 through C6 and U4 to U12, and in cell AE9 the factor of performance is to be entered. This factor is the comparison of the take-off speeds of the level of performance in 2006 and that of today is required to reach the K-point. For the new projects (new jumping hills) you can get this value at the FIS Nordic Office, CH-3653 Oberhofen, Phone +41 33 244 61 61, e-mail: friedrich@fisski.com.

For 2013, the factor is 1.06.

After clicking the macro button "in-run lengths with freely chosen performance increase" („Anlauflängen bei frei gewählter Leistungssteigerung") the program will give you the in-run lengths with the corresponding coordinates of the starting gates A and B. These data are to be transferred to the hill certificate. The Take-off speed v_0, which shall also be transferred into the certificate, is obtained by dividing the value v_0 from the program JUMP 2 1.4 by the given performance increase factor (1.06 in 2013).

Note: After each new entry or change of entries you must click the macro button again.

Calculation example - Large hill in Almaty
The previous profile optimization with the program JUMP-2 1.4 can be skipped. The calculation example is intended to show only the further processing with the program JUMP-2 2.0. We start from the profile data, issued by the program JUMP-2 1.4:

$\alpha = 11°$, $\gamma = 35°$, $t = 6.80$ m and $r_1 = 104$ m in column C3 to C6
$w_K = 125$ m, $h/n = 0.578$, $s = 3,10$ m, $r_L = 310$ m, $r_{2L} = 156$ m, $r_2 = 107$ m,
$\beta = 33.5°$, $\delta\beta = 3.3°$ and $\beta_L = 30.8°$ in column U4 to U12
Performance increase 1.06 in the cell AE9.

After clicking the macro button "in-run lengths with freely chosen performance" („Anlauflängen bei frei gewählter Leistungssteigerung") is the program's in-run length $e_2 = 83.6$ m and e_1 for the jumping hills with and without cooled in-run track with 101.2 m and 110.1 m with the corresponding coordinates of the starting gates A and B.

The above approximation formulas provide $e_1 = 98.8$ m and $e_2 = 80.6$ m for the fast track. These are 2.3 m and 3 m too little.

In the sheet tabs In-run and Landing hill the result is shown graphically.

These data are to be transferred to the project plans and to the hill certificate. The new take-off speed v_0 is calculated to be 26.56/1.06 = 25.06 m/s, which must also be entered into the certificate.

Control calculation
The two programs integrate the underlying differential equations of the calculation in different ways. One can verify the following parity of the results of the two programs: First, the in-run length is to be determined which allows a jumper to reach a $v_0 = 26.56$ m/s (friction angle $\rho = 1°$) on a faster track. By trial and error with input of different in-run lengths into the cell C10 one will find the in-run length of 95.25 m. In the Construction standards v_0 is defined as the take-off speed that allows the top jumper to fly to the K-point in calm wind conditions. Comparing the distance of 125.71 m, shown in the cell C12, with the $w_K = 125.4$ m calculated by the program JUMP-2 1.4, then the deviation is 31 cm, or about 2 per thousand. The reason for this small deviation is different rounding of the intermediate values.

Hans-H. Gasser,
Member of the FIS Subcommittee for Jumping Hills

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