HMD

Market
There is a market for Glider competitions.
FAI CIVA may be interested in a set of minimum 20 units + a ground station + one system operator to be rented and paid by the organizer.
There may be a market for 50-100 units to be purchased by Glider pilots and national aeroclubs.

There is also a market for Power Competitions.
Maybe 100 units to be used at competitions and 200+ to be used by pilots and local aeroclubs. The power aircraft may be very interested in the GPS based box out system. Maybe even transmitting box outs to the judging line.

Technical requirements for Glider Aerobatics
The range requirement is from the top of the box 1200m to the judging position 250 m outside the box.
It is good if the system can follow the aircraft during the entire tow. This means a range of around 3 km.
The installation is in most cases on a shelf behind the pilot for the Swift and on the front seat support for the Fox. The Box and the ground station should remain in contact even if the Aircraft is performing aerobatic maneuvers.

Typical set up

A. Aircraft with one installed Box.
B. One person assigned to provide and install the unit to the holder in the aircraft.
   The holder or bracket must be installed by the aircraft owner or the pilot. This responsibility should not be carried by the organizer. There might be complicated insurance issues if a unit becomes loose and it has been installed by a young volunteer working for the organizer and not by a technician or owner.
   To install a unit to a holder according to a written instruction at the contest site is acceptable.
C. Ground station located close to the Chief Judge and to the Video cameraman.
   The start and the Judging lime may be 1,5 km from each other. Proper communication between the starting point and the ground station may need an elevated antenna at the ground station. This has sometimes been a problem with the ground crew holding up units in the air for calibration.
   The Chief Judge must be able to hear the beeps. Either by being close or having a separate slave unit.

I have flown with 3 types of HMD systems. This is how they work.

1. **On the ground before start**
   It is acceptable to have fewer units then aircraft and install units before start and remove them after landing. The minimum number of units is 10, but if the cost is acceptable 20 is better and one unit in each aircraft is the optimum. The battery should be effective from 09.00 in the morning until 20.00 in the evening with maybe maximum 8 flights per aircraft. It is acceptable to collect the units in the evening and charge them over night.

   Some system had a test function. The ground crew could press a button and you could hear the beep sitting in the aircraft and if necessary adjust the volume.

Signal transmitted to the ground station. Sound + maybe a label. Then the ground station knew that the system next to be launched was working. I believe that some systems had an ID number so that the ground station and ground crew knew that ” box no 5 was in aircraft SE-URH, calibrated and ready to be launched”.
The system also needed to be calibrated before every start.
The altitude is the altitude above ground with the launching point as zero reference.
The system should be accurate in very different ambient temperatures from +12 degrees C to +40 C. The storage temperature inside the aircraft may be up to +70 degree C if left installed for a few hours.

2. **At 150 m climbing**
   One beep. Normally adjusted with some safety margin, let’s say 140 m. The pilot can hear the beep and look at the altimeter and precisely know where the disqualification floor is. The altitudes must be adjustable. On some occasions the Box floor is raised due to some obstacles or other circumstances.
   Signal transmitted to the ground station. Sound + maybe a label.

3. **At 200m climbing**
   One beep. Normally adjusted with some safety margin, let’s say 190 m. The pilot can hear the beep and look at the altimeter and precisely know where the penalty floor is and the Chief Judge knows that the system is working.
   Signal transmitted to the ground station. Sound + maybe a label.

4. **At 1200m climbing**
   The system starts beeping continuously Again some safety margin maybe 1220 m.
   Signal transmitted to the ground station. Sound + maybe a label.

5. **Above 1200m**
   Continuous beeping.
   Signal transmitted to the ground station. Sound + maybe a label.

6. **At 1200 m descending**
   The beeping stops
   Signal transmitted to the ground station. Sound + maybe a label.

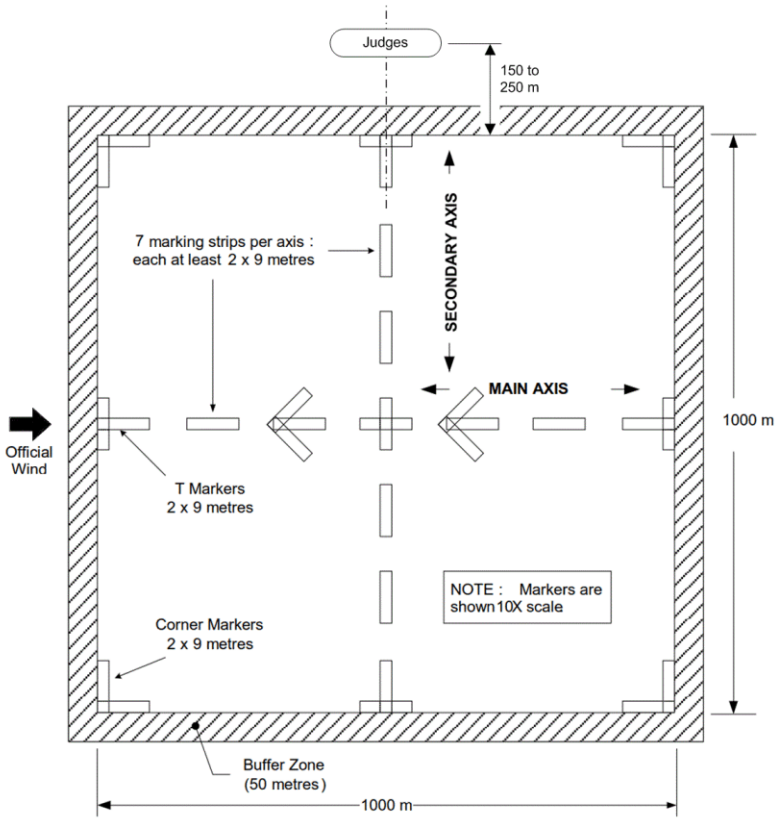
7. **During the first manoeuvre**
   If you start below 1200 m but during the first manoeuvre fly over 1200 m the system beeps again. (And you have a penalty of 70 p)
   Signal transmitted to the ground station. Sound + maybe a label.

8. **At 200 m descending**
   The beep starts at 200 m and continues to beep as long as the aircraft is between 150 and 200m. If the Aircraft flies under 200 m and after a moment climbs over 200m the beep stops and starts again when the Aircraft again flies below 200m.
   Signal transmitted to the ground station. Must be a sound so that the chief judge can hear the beep and at the same time see if the aircraft is in level flight or not when it beeps. Signal transmitted to the ground station. Sound + maybe a label.

9. **At 150 m descending**
   The beep stops
   Signal transmitted to the ground station. Sound + maybe a label.

10. **On the ground after the flight**

The Red Van system produced a GPS map of the flight. The Judges and the pilot could see the positioning and boxouts. The position of the box must be entered very precisely in the system. There were many discussion if the coordinates were correct or not after box outs. The box has a 50 m Buffer zone (hatched area). The aircraft is out when it is 50 m outside the box. This GPS map is not a requirement by the rules but was very popular with the pilots.



All systems had a graphical representation of the whole flight in a computer file. Altitude versus time.

This is what the rules says today (The 100 m has been raised to 150 m)

C. APPENDIX C: RULES FOR THE USE OF ELECTRONIC HEIGHT MEASURING DEVICES (HMDs)

1C.1. Types of HMDs

1C.1.1.1 Two types of Height Measuring Devices have been used in glider aerobatic world championships, the Czech HMD and the Polish “Red Van” system.

1C.2. Functions of HMDs

1C.2.1.1 An onboard transmitter sends signals to the ground receiving equipment (at the Chief Judge position) when the glider descends below the upper or lower height limits or the disqualification height. The ground equipment emits an audio signal (″beep″) and records the height of the glider whenever signals from one of the onboard transmitters are received.

Discrete height limits can be selected whenever this becomes necessary due to terrain or other reasons.

1C.2.1.2 The HMD box in the glider cockpit gives the following audio signals to the pilot:

1) Functional checks at 150/200 m during tow (one “beep” each),

2) Continuous signal (“beep-beep-beep”) as long as the glider flies above the upper height limit.

3) Descent below the upper height limit is indicated by the stop of the continuous signal.

f) Descending below 200 m until reaching 150 m: Continuous signal (“beep-beep-beep”).

If the glider climbs back above the respective height, the signal will be repeated every time it descends below that height again.

1C.3. Technical Characteristics

1C.3.1.1 The onboard transmitter will always send its signals according to the pre-programmed height limits. Small tolerances are preset when programming the transmitters. This ensures that the signal for the upper height limit will be transmitted at an actual height slightly above the limit, whilst the signals for the lower limit and the disqualification height are transmitted slightly below the exact height. The Chief Judge decides which tolerances will be set when programming the airborne transmitters.

The guaranteed overall tolerance of the HMD systems is considerably smaller than the tolerances of the conventional altimeters used in gliders. Pilots must further understand that unlike mechanical altimeters, the electronic pressure sensor in the HMD has no hysteresis, i.e. it is not influenced by rate of descent or climb. This means that whilst the mechanical altimeter displays a significant lag during rapid changes of altitude (always indicating low in a climb and high in a descent), the HMD will transmit its signal exactly at the pre-set height. Under certain conditions, however, there may be a short delay of typically 2-3 sec. before the ground equipment receives the signal due to the technical limitations of the data link system used.

1C.4. Operating the HMD

1C.4.1.1 Whenever an HMD is in use, it will be the primary reference for the Chief Judge to verify compliance with height limits and for decisions on penalties or disqualifications due to height infringements. HMD audio signals are recorded together with the official video.

1C.4.1.2 Calibration, installation, setting up, checking, and removal of the HMD onboard transmitters will be performed by persons specifically designated for this duty.

1C.4.1.3 Towing height with HMD is always at least 50 m higher to ensure proper functioning of the device.

1C.5. Malfunction or Failure of the HMD

1C.5.1.1 Whenever a competitor notices or assumes a malfunction of the HMD (e.g. the audio signal does not stop below 1200 m), they may return for landing without starting the programme. After starting the programme, there is no justification for breaking off due to an assumed malfunction of the HMD.

1C.5.1.2 A failure of the link between the HMD and the official video recording equipment has no influence on the validity of the HMD measurements, as long as the normal functions of the HMD, as described above, are not degraded.

1C.5.1.3 If the HMD system becomes unserviceable during the contest, procedures for towing and determining infringements of height limits for subsequent flights will be in accordance with the rules laid down in paragraph **Fel! Hittar inte referenskälla.**