AN INTEGRATED CAMERA-BAROGRAPH SYSTEM FOR SOARING CONTESTS

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1.0 INTRODUCTION

The use of a photo start in soaring contests in place of a start gate is becoming the norm since it greatly simplifies the ground operations and reduces the number of ground personnel required. It also enhances safety by allowing large separations between the start locations of the various classes, and allows a silent start. This type start is presently in common use in Europe for both pure sailplane and auxiliary-powered sailplane soaring contests and should be in use in the U.S. in the next year or two. A principal impediment has been the lack of adequate on-board systems that record the time of the start photo and the start altitude to the necessary timing accuracy.

2.0 SYSTEM REQUIREMENTS

Listed below are the requirements on a flight verification system to satisfy the basic contest requirements:

- A camera for start and turnpoint photos;
- A precision clock for start photo timing;
- Record of altitude at time of start photo;
- Record of maximum altitude during flight;
- Simple synchronizing of on-board clock with contest clock;
- Ease of use for both pilot and contest officials;
- Safeguards against cheating; and,
- Small, rugged, and reliable.

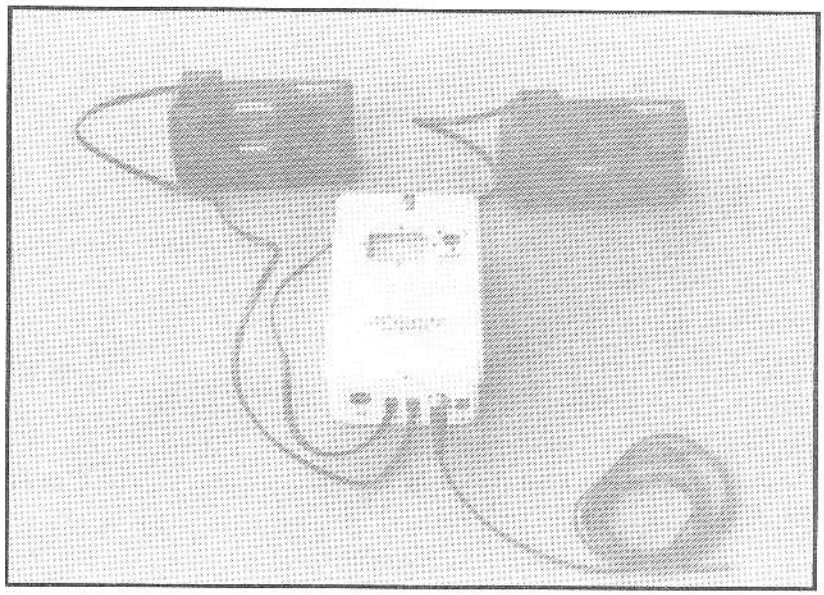

FIGURE 1. Photo of dual camera motorglider system showing camera cables and engine operation sensor and cable.

Auxiliary powered sailplanes impose the following additional requirements on the flight verification system for use in auxiliary powered sailplane contests and to allow auxiliary powered sailplanes to fly in contests with non-powered sailplanes:

- Maximum altitude of pre-start engine operation;
- Duration of engine operation during task;
- Time of each turnpoint photo; and,
- Time of initial engine operation during task.

3.0 SYSTEM DESCRIPTION

An integrated system based on the XYLON

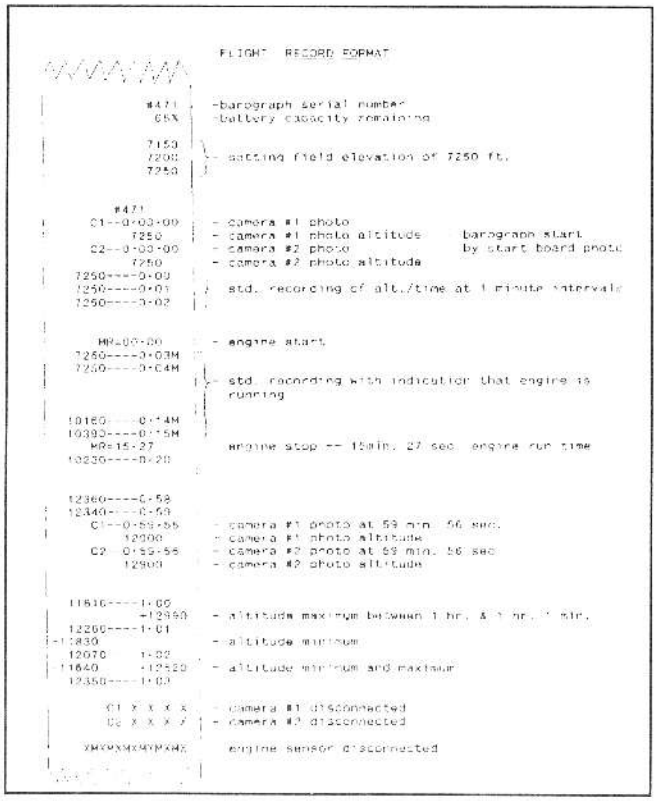

FIGURE 2. Annotated flight record tape showing the recording format for the various events.

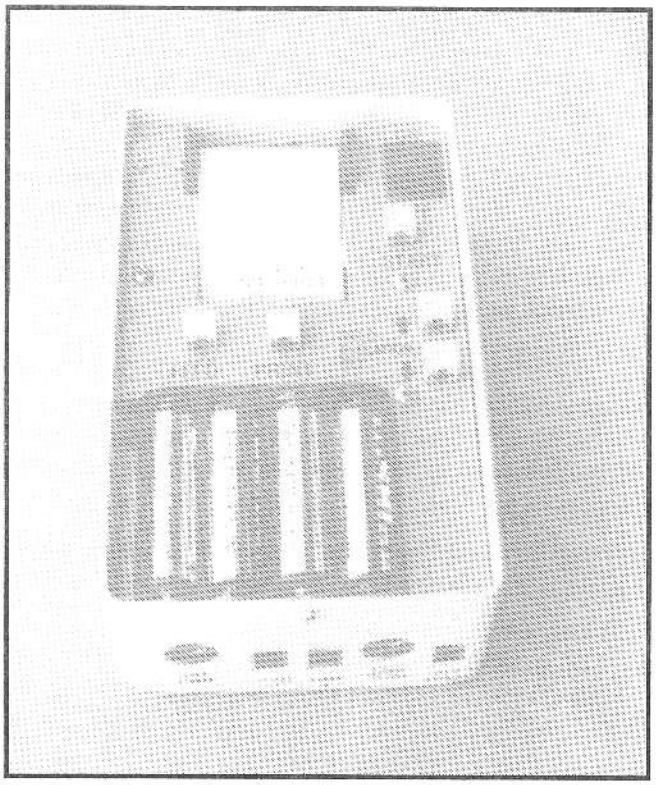

FIGURE 3. Barograph with cover removed showing control panel, record tape, and batteries.

digital barograph, functioning as a flight recorder, combined with modified, fixed focus, 35mm, data-back cameras has been developed which provides the necessary photos (start board, start, and turnpoints) along with the altitude and the time of these events to one second accuracy. It also provides a barogram of the complete flight to verify compliance with an altitude constraint.

For use in an auxiliary powered sailplane, it senses and records both the time of each engine use and the duration of each engine run to an accuracy of one second.

The barograph is automatically started with the taking of the start-board photo, thus eliminating the problem of forgetting to start the barograph. The system protects against cheating by recording any disconnect of a camera or the engine sensor after the start-board photo has been taken. In addition, single function cables and connectors are employed to allow easy verification that no additional wires and switches have been included. An output connection is included to provide start and turnpoint signals to a flight computer. The system may be configured with either single or dual cameras and barographs. Figure 1 shows a dual-camera motorglider system.

A simple, easily-readable digital printout is produced and is available immediately after the flight without the use of any additional equipment. Figure 2 shows an annotated flight record tape that shows the recording format for the various events.

If a contest official records the time of the start-board photo, which starts the barograph clock, then the start time and the pilot's speed can be determined immediately after the flight without waiting for the developing and reading of the film.

3.1 BAROGRAPH

The barograph is an advanced version of the XYLON BAR-350 digital printing barograph that has been in use since 1985 and is accepted by the SSA, NAA, and FAI for all record flights. It employs a solid state pressure sensor with a special temperature correction program, a microcontroller, quartz crystal timing, and a small digital printer (see Figure 3). Internal batteries or sailplane power may be used. A separate connector and cable is used for each camera, external power, engine sensor, and the flight computer for easy system verification (see Figure 4).

The altitude is measured every second and printed at one minute intervals along with the elapsed time. A two minute interval may be selected. An altitude maximum and/or minimum occurring during the one minute interval is also printed, and identified by a + or - . The actual pressure altitude is printed on the flight record tape because each instrument's calibration is in its software. Camera events are recorded with a one second timing accuracy.

Auxiliary powered sailplane engine operation is indicated by a detector which senses the electric field around the spark plug wire. No direct connection to the engine electrical system is required and there is no engine-on indication with a windmilling propeller. Run times are

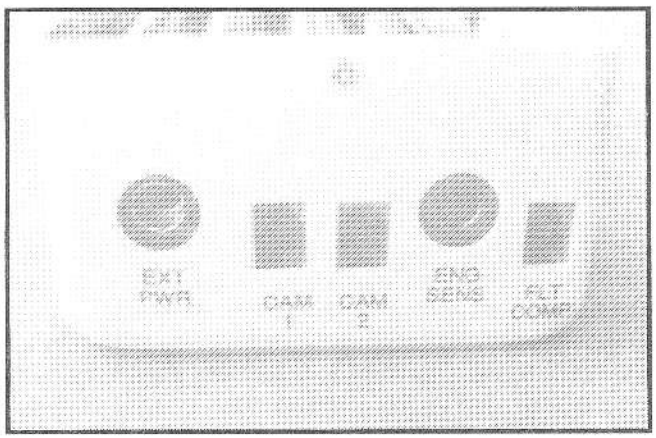

FIGURE 4. Close up of barograph case showing connector ports for cameras, engine sensor, external power, and flight computer.

recorded to the nearest second and the engine start and stop are shown within the minute interval in which they occur.

Technical data is presented in Table I.

3.2 CAMERA

The camera is a modified version of the Chinon Auto GL, a simple, reliable, 35 mm, data-back camera. It is fixed focus, with a 35 mm/f4.5 lens and has motorized film transport with automatic film advance and switch initiated rewind. Clock time in hours and minutes is recorded on each frame. An external switch/connector module has been added to provide the shutter signal to the barograph (see Figures 5 and 6).

Technical data is presented in Table II.

4.0 SYSTEM OPERATION

It is very simple and straightforward to use the system. The inspection of the system installation by a contest official to verify that there are no extra wires or switches in the system can be accomplished easily and quickly because each cable and connector is single function. As with any barograph, an airplane flight or an altitude chamber test is necessary to verify the altitude accuracy. A stop watch will quickly verify the time accuracy.

Prior to the flight the barograph power is turned on and the altitude is set to the field elevation. The contest official then initials the record tape and seals the barograph. The

BAROGRAPH TECHNICAL DATA

Barogram Form - Digital printout on a 1-1/2 inch plain paper tape (~12 inches of tape per hour of flight).

Altitude Range - 0 to 35,000 ft. (0 to 10,000m.)

Altitude Measurement Interval - One second.

Altitude Recording Interval - One or two minutes. Intermediate maximum and/or minimum also recorded.

Altitude Recording Accuracy - ± 10 ft. (± 5m.)

Start of Flight Recording - Manual or by start board photo.

Record Identification - Barograph serial number printed at the beginning of each record.

Maximum Recording Time - 12 hours at 1 min. print interval (capacity of the take-up spool).

Tape SupplyCapacity - 18 hours.

Power - Four AA alkaline batteries. (7 to 15 volt external power option available)

Battery life - 20 hours of operation with automatic protection against low batteries.

Operating Temperature Range - 0°C to +50°C (32°F to 120°F). Thermal enclosure available for operation in extreme cold.

Event Recording - Two separate camera or other event inputs. Altitude and time of the photo recorded to 1 second accuracy. Recorded indication if camera disconnected.

Flight Computer Interface - An output signal in the form of a switch closure each time a photo is taken to signal the flight computer to start the task or step to the next leg.

Engine Operation Recording (motorglider model only) - Time of each engine operation recorded to the nearest minute, duration to the nearest second. Recorded indication if sensor is disconnected.

Sealing - Electronic and conventional wire and lead.

Size - 5.1 X 9.5 X 15.9 cm.

Weight - 567 g.

TABLE 1.

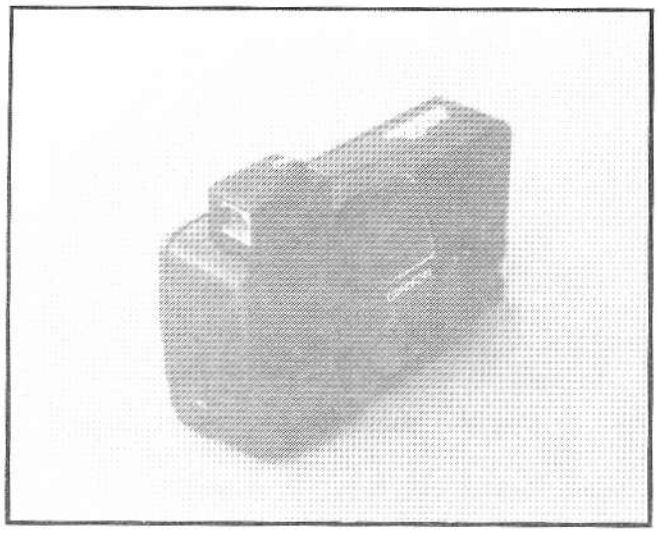

FIGURE 5. Camera with swith/connector module.

cameras are loaded with film and then, along with the barograph, are installed in the sailplane and the cables connected.

When the start-board photo is taken, the barograph is automatically started. The cameras will record the official contest time shown on a large battery-powered clock, with a sweep-second hand, mounted on the start board (see Figure 7). This is the zero reference time for the flight recording.

If the contest official records the time of the start board photo then the start time is easily calculated without developing the film and also eliminates the need for the pilot to transmit his start time to his ground crew for relay to the contest officials. When the film is developed for verification of the turnpoints, the clock time corresponding to the start of the flight recording can be verified. There is no need to do the difficult job of reading the time imprint on the film to obtain the start time or to take the multiple pictures of the contest clock to synchronize the camera clock. The time imprint on the film provides a redundant way of determining the start time, but only to a one minute accuracy.

5.0. CONCLUSIONS

The need for a reliable system that provides one second timing accuracy for the start photo and start altitude measurement for soaring contests utilizing the photo start has been met by the XYLON Integrated Camera-Barograph System. The use of a photo start greatly simplifies the ground operations and the number of ground personnel required as well as enhancing safety by allowing large separations between start locations of the various classes. The need to synchronize the camera clock and to read the time imprint on the film has been eliminated. The use of this integrated camera-barograph system for record attempts would greatly simplify the start and homologation processes.

CAMERA TECHNICAL DATA
Film Size - 35 mm, full frame
Lens - 35mm / f4.5, fixed focus
Film Transport - Motorized; auto advance, manual switch rewind
Data Recorded - day-hour-minute or year-month-day on each frame
Shutter Signal Output Switch closure
Power Source - One 3v lithium for clock and 2 AA batteries for film transport
Size - 12.9(w) x 5.2(d) x 9.0(h incl. switch module) cm. weight - 270 g.
Mounting - 1/4-20 thread mounting socket

TABLE 2.

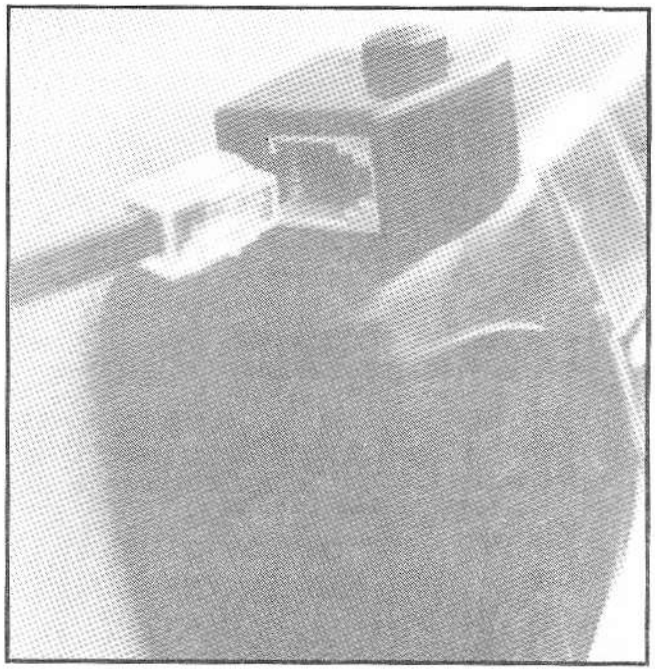

FIGURE 6. Close up of camera switch/connector module showing cable connector and connector port.

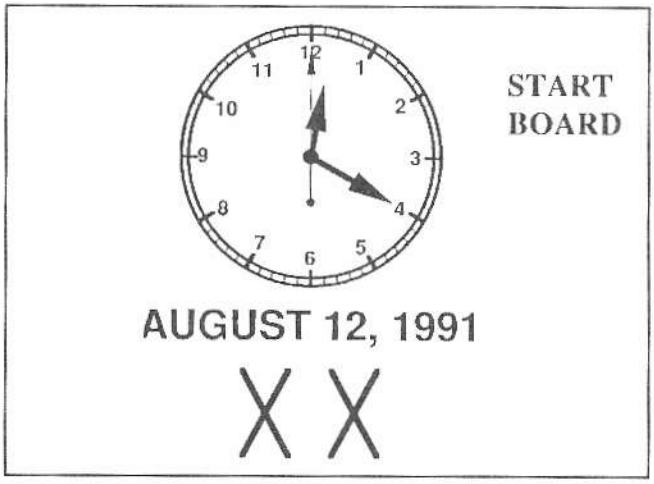

FIGURE 7. Start board with clock.

6.0 REFERENCES

McKenney, J. D. and Schurmeier, H. M., 1988, Barograph With Magnetic Compass Heading Recording, Technical Soaring, Vol. 12, No. 3, July, 1988.