

Test Title: **Cold Soak Tests of Parachute Ejection System**

Test Number: CS040115-1

Conducted by R.Nakka, 13 January, 2004

Objective:

Flight *Ze-3* of the *Zephyr* rocket suffered a partial failure of the Parachute Ejection Triggering (PET) system, which resulted in delayed drogue deployment. The ambient temperature at the time of launch was -15°C . As the drogue charge triggering system is redundant, with two fully independent systems designed to fire the ejection charge, the occurrence of a dual failure was particularly unexpected. No obvious technical fault or error in procedure was found during post flight inspection. As such, it was felt that the acutely cold temperature was indirectly responsible. All electronic components used in the PET system were rated at -20°C or colder, and an earlier cold soak test revealed normal operation of the circuit at -27°C . However, for that test, the circuit only was tested with a "Xmas" bulb in lieu of an igniter charge. The ejection pyro charge for *Ze-3* was "Crimson Powder", a new development that replaced the Black Powder charge used for all previous flights, with the exception of *Ze-2*, which successfully debuted the new material. The intent of these cold soak tests is to conduct more representative testing, having the PET system fire an actual ejection charge similar to that that used for *Ze-3*.

Method:

Two cold soak tests were conducted, one at -18°C and one at -25°C . For both tests, the drogue timer (exclusively) was tested.

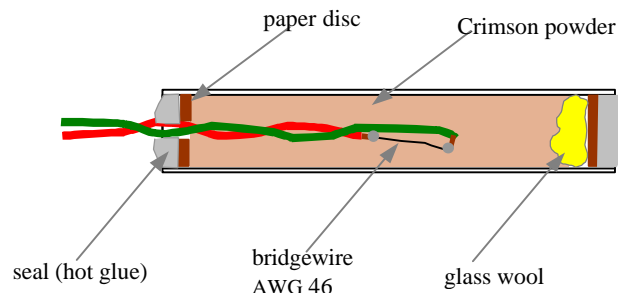
The PET module was configured as per *Ze-3*, with the same batteries being used, and the drogue delay unchanged at 12 seconds. These same batteries were also flown on *Ze-1* & *Ze-2*. The drogue battery voltage (zero load) is shown below:

Prior to *Ze-3*
6.36 V.

Prior to cold-soak
6.30V

Battery type was Duracell Lithium Ultra 223, nominal voltage 6.2 V.

The ejection charges were prepared in same manner as for *Ze-3*, using 0.80 grams *Crimson Powder* enclosed in a 35 mm length of plastic soda straw, $\frac{1}{4}$ " (6.4mm) ID. See figure below:



The bridgewire was “superfine” nichrome AWG 46 (0.0015”), of the lengths & resistance shown below:

	Length(mm)	Resistance (ohm)
<i>Ze-3</i>	9.1	8.6
Test #1	9.3	8.7
Test #2	11.8	11.1

Cold soaking was achieved by placing the PET module and ejection charge into a deep freezer Prior to conducting a test, the freezer thermostat was adjusted to the target temperature and allowed to stabilize for a day.

Prior to placement into the freezer, the drogue timer delay was measured at room temperature and found to be 12.1 seconds. The igniter charge was connected to the drogue timer output, then the PET module and igniter were placed inside a plastic bag, and then deposited into the freezer, where it was allowed to remain for 20 hours. After removal, the timer delay was tested (with the output in the safe mode) and measured with a stopwatch. The system was then armed and triggered.

Results:

Test #1 Temperature: -18°C

In SAFE mode, time delay after cold soak was measured and found to be 12 seconds. After triggering in ARM mode, the ignition charge fired after the expected delay.

Test #2 Temperature: -25°C

In SAFE mode, time delay after cold soak was measured and found to be 12 seconds. After triggering in ARM mode, the ignition charge fired after the expected delay.

Discussion:

The PET system and *Crimson Powder* ejection charge both performed completely normally, even under exceptionally severe cold temperature conditions.