Advanced drop tests from stratospheric balloons

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Stratospheric balloons are used for scientific measurements, drop tests of aerospace vehicles and parachute systems. Drop test missions can include free falling objects weighing up to 1 ton or more and has been done since the 1980:s. These tests have to be performed according to our strict flight- and ground safety rules. The aim of this paper is to give a short introduction into concept and the applications both in the past, present and the future

I. Introduction

SInce the middle of the 1980:s advanced drop test from stratospheric has been performed from SSC launch site Esrange Space Center. The center is situated in the northern part of Sweden close to the town of Kiruna, 180 kilometers above the Arctic Circle. Esrange Space Center has an uninhabited and restricted impact area of 5200 square normally used for sounding rocket. Esrange Space Center has long experience of launching stratospheric balloons, since 1974 has more than 550 balloons been launched. The impact area is ideal for performing drop tests from stratospheric balloons.

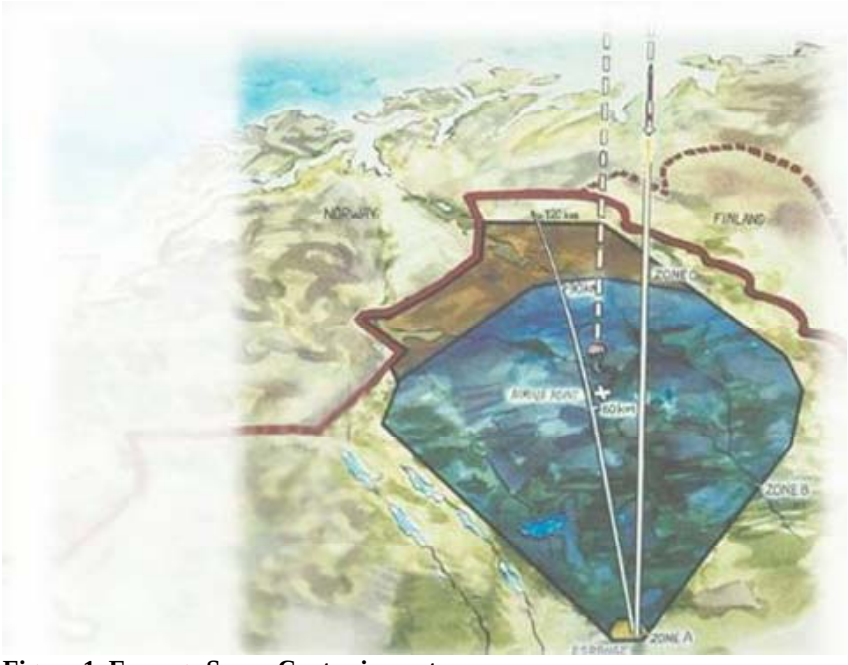

Figure 1. Esrange Space Center impact area

All flights from Esrange Space Center are performed according to SSC:s strict flight- and ground rules.
The unique position of the Esrange Space Center gives the right wind conditions to be able to perform drops tests. The winds high altitude above the Arctic Circle are fairly predictable and consistent, called the polar winds. During summertime the winds blow in westerly direction and in the wintertime in an easterly direction. For a period in both autumn and spring there are low winds, this is called the turnaround period.

The drop test payload may vary in size and with a weight up to 1000 Kg and more. The most difficult challenge is to lunch whit the correct winds which will carry the balloon and its payload inside the impact area at the right altitude to get a successful drop of the payload.

II. History

In the past there have been several drop tests performed from the Esrange Space center. The first test was performed in in the late 1980:s and the latest in 2011.

A. The MICROBA Project

The aim was to perform microgravity experiments during the free flight of the payload. Cold gas thrustera was used as attitude control system

Figure 2. MICROBA launch

B. The HUYGENS Probe

The drop test of the HUYGENS probe was to prove the design of the probe which should be landed on Saturn's moon Titan. The drop was successful and proved the design stable. In 2005 the probe safely landed on the moon Titan.

Figure 3. The HUGENS probe in the assembly hall

C. High Speed Flight Demonstrator Phase II (HSFD II)

The JAXA program was developed as series of flight experiments for the research of the HOPE-X Reusable Launch Vehicle.

The aim with the campaign was to clarify the transonic aerodynamic characteristics of a winged re-entry vehicle by drop testing it from a high altitude stratospheric balloon.

Figure 4. HSFD II launch

D. D-SEND#1

The JAXA project demonstrates a reduced sonic boom for aircraft with a non-conventional shape by releasing drop models from a high altitude (20-30 km) so that they reach supersonic speeds and produce sonic booms. The drop models include electronics that measure their motion, while a microphone system a lower altitudes (0-1 km) records the sonic booms.

Figure 5. D-SEND#1 gondola with two drop bodies

SSC's engineers have developed the balloon gondola and four drop models according to JAXA's specifications. Three of the drop bodies were equipped with an inertial measurement system and onboard telemetry system that downlinked real time data to the customer.

SSC also conducted the two drop tests. Each gondola released two drop models in quick succession, thus making SSC the first to drop such heavy objects from a single balloon in sequence.

JAXA used their own developed recording system on ground with microphones in the field. The low frequency microphones and data recorders are installed at altitude of: 1km,750m,500m of tether line hanging below a blimp. In order to measure the effect of the turbulence to the sonic boom signature.
These microphone systems where placed on three different locations in the impact area.

Figure 6. Ascending Blimp with microphones

III. The future

There are demands for this kind of drop tests both now and in the future. Already there are plans for new drop tests.

A. D-SEND#2

D-SEND#1 project will be followed by theD-SEND#2 project, where an experimental supersonic airplane model (unmanned aircraft with no engine and capable of autonomous flight) is dropped and the sonic boom is measured. The goal is to design a silent supersonic transportation system that is economically viable and eco friendly for travels in the 21st century. The flight of D-SEND#2 is planned for 2013.

Figure 7. D-SEND#2 aircraft

B. HADT

HADT is a part of the ExoMars Program which aims to land rovers to explore the environment on Mars. Tests on descend and landing systems will be performed by drop tests at Esrange during 2013.

Figure 8. ExoMars vehicle