

## "THE NATIONAL SCIENTIFIC BALLOON FACILITY"

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## ABSTRACT

More than 12 years ago the National Scientific Balloon Facility was established to improve capabilities of scientific ballooning. In 1963 the first balloon was launched from the facility's launch pad. During this period payloads have increased from 400 pounds (181 Kg) in 1963 to 1500 pounds (680 Kg) in 1973. Average balloon volumes have increased during the same time period from 3.0 MCF (84,951 M<sup>3</sup>) to 9.5 MCF (269,012 M<sup>3</sup>) in 1973.

The facility offers complete operational support to its users including launch, tracking, recovery and electronic support. Various launch techniques and electronics are described.

## OPERATIONAL SUPPORT

More than 12 years ago a decision was reached at a conference of research scientists interested in or experienced in ballooning to establish a scientific balloon support group within the National Center for Atmospheric Research.

Rapid progress in the atmospheric sciences and astronomy required improvement in ballooning capabilities. The NCAR National Balloon Program was designed to help spur that advance and to make it easier for scientists from the scientific community as a whole to use the improved capabilities as they were developed.

Initially the facility was expected to focus its principal attention on the support of individual complex, beyond the state-of-the-art projects. As physical facilities, instrument systems and "know-how" were developed as by-products of the initial intent of the facility, they were made available to the scientific community as a whole to simplify the ballooning problems facing the individual scientist.

On the 28th of May, 1962, the National Center for Atmospheric Research and the National Science Foundation announced the establishment of the year round NCAR Scientific Balloon Flight Station in Palestine, Texas.

In August of 1963 the first balloon lifted off the facility launch pad. Since that time we have served 55 universities, 6 research organizations and 17 government agencies with more than 900 balloon flights from Palestine, Texas, and several other U. S. launch sites, as well as from nine foreign countries. During this period the average payload has increased from 400 pounds (181 Kg) in 1963 to 1500 pounds (680 Kg) in 1973. The average balloon volumes have increased during the same time period from 3.0 MCF (84,951 M<sup>3</sup>) to 9.5 MCF (269,012 M<sup>3</sup>). Balloon capabilities have steadily advanced; in 1968, a 15 MCF (424,755 M<sup>3</sup>) balloon was the largest operational balloon flown, and in 1974, flights are planned using 53 MCF (1,415,850 M<sup>3</sup>) balloons.

Payloads ranging in weight from less than 100 pounds (45 Kg) to over 10,000 pounds (4,536 Kg) have been launched by the facility's personnel. Altitudes of over 156,000 feet (47.5 Km) with a payload of more than 800 pounds (363 Kg) have been achieved. Average flight duration has tripled over a ten year period.

The NSBF provides complete operational support to its scientific users; this includes balloon consulting services, pre-flight rigging, launch, tracking,

and recovery services, electronic and meteorological support, plus flight services from locations where the scientific objectives are best achieved.

It would take many pages to discuss in detail the many techniques and services required for the NSBF to fulfill its mission so I will just briefly describe the major portion of the NSBF operational support.

Numerous launch techniques are used by the facility, dependent upon experiment weight and the balloon system used.

The most common technique is the dynamic launch using a single cell balloon with a launch vehicle that supports the scientific gondola prior to launch. The inflated balloon bubble is constrained by a spool, and when the bubble is released from the spool, the launch vehicle maneuvers the payload directly under the ascending balloon. When the balloon is fully extended above the payload it is released from the launch vehicle. This technique permits compensation for changes in surface wind directions thereby providing some flexibility during the launch. The wind constraint for a dynamic launch is normally 10 knots. This may vary with length of the system, maneuvering area and type of vehicle used. Several launch vehicles are used by the facility for dynamic launches. The largest is Tiny Tim, a 52 ton (51,891 Kg) vehicle specially designed for balloon launching. Gondolas as tall as 33 feet (10m) and weighing up to 6155 pounds (2,791 Kg) have been successfully launched from Tiny Tim.

Very heavy payloads are launched by the static technique usually using tandem systems consisting of a top balloon and a main balloon separated by a transfer tube. The top balloon contains enough gas at launch to lift the entire system. During ascent the expanding gas from the top balloon is transferred to the main balloon. Prior to launch the entire balloon system is erected over the payload under continuous control of a winch vehicle. The main balloon is sheathed in a plastic reefing sleeve to prevent sailing prior to launch. The winch vehicle used at the NSBF has a capacity of 3460 feet (1.05 Km) of 5/8 inch (1.6 cm) cable and can safely handle cable tensions as great as 40,000 pounds (18,144 Kg). Gross loads of 14,000 pounds (6,350 Kg) have been launched by the facility using this technique.

For electronic support the facility provides balloon control and scientific telemetry, altitude sensors, telecommands and ground support equipment. In the near future a new generation Consolidated Instrument Package (CIP), will be placed into operation and will include a single command system for both balloon control and scientific commands, plus a telemetry system which has the capability to handle data transmissions on the flight over an L-Band RF carrier. The ground station associated with the CIP will record scientific data and flight parameters including time, altitude and balloon position, on incremental magnetic tape for post-flight processing.

The CIP will contain the following equipment:

1. PCM Data Encoder
2. PCM Command Receiver-Decoder
3. Rosemount Pressure Transducers
4. Omega Receiver
5. Twelve Subcarrier Oscillators (when required)
6. "L" Band FM Transmitter

The ground station at Palestine is equipped with PCM data decommutation and real-time display equipment, omega processor, time code generator, time receivers (Loran and WWV), Analog tape recorder, PDP-11/20 computer with incremental tape recorders, and PCM command encoders/transmitters. A down-range station is maintained with the same equipment except for the computer.

Data may be recorded on analog tape and replayed through the computer at Palestine to generate an incremental tape.

Complete meteorological service is located at the facility for the sole purpose of providing weather information for balloon flights. The weather briefings for each balloon flight include the forecasts for the launch, ascent track to float altitude, the trajectory, descent track to impact, and the recovery area weather.

Accurate position reports of the balloon's trajectory have become essential for many of the scientific experiments flown on balloons. We provide continuous tracking. This is accomplished by several methods including radar, radio direction finding and electronic navigation techniques. Two twin-engine tracking aircraft are operated by the facility to provide the necessary balloon position reports.

The safe recovery and return of scientific equipment to the Balloon Facility is of prime concern to operations personnel, and is accomplished by experienced technicians using specialized equipment.

As many of you are aware, balloon operations has evolved into a very complicated exercise and interface of technicians, machines and electronics. A typical balloon flight of today involves launch vehicles as large as the heaviest earth movers, multi-engine aircraft, the most sophisticated electronic equipment and special recovery vehicles.

The new 2000 ft diameter launch area at the NSBF will be inaugurated in May of 1974. This is only one of the many improvements that the facility is making to keep pace with the ever increasing requirements of the scientific ballooning community.

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DISCUSSION SUMMARY — PAPER 3.1

Questions were asked about how NCAR is financed and what share of the budget the user pays. The speaker noted that NCAR is financed inherently by the National Science Foundation. All users are charged for the balloons and helium that they use. Foreign users are charged an additional \$11,000 fee for each successful flight. The user receives complete operational support including launch, tracking, recovery, weather forecasting, use of electronic ground station and other ground facilities. The \$11,000 charge for foreign users is not levied in an unsuccessful flight if the failure is attributable to NCAR equipment.

The possibility that the facility might be overcrowded was addressed. It was noted that all users are treated with equality whether foreign or U.S. The instrument that is ready first is generally the one that flies first. It is possible to fly two separate gondolas at the same time. Plans to fly four on December 27, 1974, are being worked out.