INFLATABLE SPHERICAL SATELLITES

The 12-foot inflatable spherical satellite employed as a research vehicle by NASA was conceived, fabricated, and packaged at the Langley Research Center by a team of scientists, engineers, technicians, and skilled modelmakers. The material for the Scout satellite was laminated to NASA specifications by the Reynolds Metals Company.

The satellite was developed under direction of William J. O'Sullivan, Jr., head of Langley's Space Vehicles Group and a pioneer in the field of research with inflatable and erectable space structures. He directed the design, development, and packaging of the Echo I passive communications satellite which has been in orbit since last August 12.

O'Sullivan first proposed in January 1956 the use of lightweight spherical satellites in measuring the minute aerodynamic drag experienced by earth satellites in the outer fringes of the earth's atmosphere— to obtain density data by observation of the orbit decay.

There have been three previous attempts to orbit small spherical satellites in air density-drag measurements experiments from Cape Canaveral. Smallest was a 30-inch satellite launched on April 13, 1959, on a Vanguard vehicle. The other two were
12-footers-- the first on October 22, 1958, in a Jupiter C rocket and the second in a Juno II vehicle on August 14, 1959. In all three flights, the launch vehicle failed to make orbit.

The plastic film in the four-ply laminated 12-foot sphere to be launched in a Scout vehicle gives the satellite the toughness it requires to be folded into a compact package for ease of transport into orbit. The aluminum foil serves several purposes-- making the satellite stiff, highly reflective of sunlight and radio waves, electrically conductive, helping regulate satellite temperature, and protecting the plastic film from the intense ultraviolet radiation in the area beyond the protective filter cover of the earth's atmosphere.

By providing stiffness, the aluminum foil permits the satellite to remain spherical without internal pressure as it orbits the earth. After separation of the satellite and payload container, the internal pressure in the sphere equalizes with the outside environmental pressure through an open valve stem in the satellite. Any remaining inflation gas is expected to be lost through punctures made in the satellite structure by micrometeorites.

In making the satellite highly reflective of sunlight, the aluminum foil permits the sphere to be tracked optically throughout the world. Studies conducted at Langley indicate that the shiny aluminum foil will reflect about 80 per cent of the sunlight which falls upon the satellite in orbit.

By making the satellite's outside surface electrically conductive through use of aluminum foil, the sphere itself serves
as an antenna for the small radio beacon attached to it for tracking purposes. The satellite is separated into hemispheres by a $1\frac{1}{2}$-inch-wide equatorial gap of an insulating material (mylar), permitting the two hemispheres to form the antenna for the tracking beacon.

The aluminum foil will not keep the temperature of the satellite within the limits required for satisfactory operation of the tracking beacon components. In an effort to obtain better heat balance characteristics, about 20 per cent of the satellite surface area has been covered with a scientific application of white epoxy paint in a pattern consisting of approximately 3,400 two-inch-diameter white dots; in a circle 36 inches in diameter around both the transmitter and battery packages of the beacon, there are about 210 one-inch-diameter dots. For protection against heat while they are in sunlight, the beacon and battery package are covered by 8 by 10-inch rectangles of white paint. The beacon and battery package are thermally decoupled from the satellite through application of the thermos bottle principle for protection against cold while they are in shadow.

The equatorial gap separating the satellite into two hemispheres has an application of white paint to protect the plastic material and prevent the sun from shining through the transparent plastic onto the transmitter and battery packages located inside the surface of the sphere.

The tracking beacon components, consisting of a radio transmitter, a storage battery package, and four solar cell packages--
each containing 70 solar cells--were designed and contracted by the Radio Corporation of America to NASA design specifications. Each solar cell package is located on the outside skin of the satellite in an arrangement to permit continuous charging of the storage batteries while the satellite is in sunlight. The radio transmitter and the storage battery package are located on the inside skin of the satellite, near the equatorial gap. Printed cable interconnects the various components of the tracking beacon system. The storage batteries will operate the transmitter while the satellite is in shadow, making it possible to have continuous day and night tracking.

Claude W. Coffee, Jr., of Langley's Space Vehicles Group and project engineer of the air density-drag measurements experiment, has been a Langley research scientist since October 1947. He was born February 24, 1921, in Sanford, Florida, and now makes his home in Newport News, Virginia. He graduated from the University of Florida with a bachelor of science degree in mechanical engineering in July 1942 and returned to the University in 1946 after World War II Army service and received a degree in industrial engineering in June 1947. During his NASA service, he has been author or co-author of a dozen technical publications.

-- END --