Both the distribution of maximum stress during inflation and the steady-state stress distribution exhibit a peak about halfway between the vent and the skirt and a maximum value near the skirt. Both Heinrich and Saari[2] and Wagner[5] have reported maximum values of stress near the skirt for ringslot parachutes, but the intermediate peak has not been observed on ringslot parachutes. The ratio of maximum to steady-state stress ranges from about 1.25 to 1.75 with the maximum value occurring near the skirt and the minimum occurring at about 30% of the distance from the apex to the skirt. The ratio of maximum stress to steady-state stress is essentially constant with dynamic pressure and is much smaller in slotted parachutes than in solid parachutes.

Acknowledgment

This research was supported by Sandia National Laboratory, Albuquerque, N.Mex., under Contract 13-9879.

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AIAA 81-1949R

Development of the ARIES Parachute System

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Introduction

ARIES is an attitude controlled sounding rocket used by NASA in support of its Space Sciences Physics and Astronomy Program. Following motor burnout, the payload follows a ballistic trajectory with approximately 8 min above the atmosphere. A parachute system is used to recover the payload after it re-enters the atmosphere at Mach 7 and slows down owing to aerodynamic drag. To develop the parachute recovery system,[1-3] an economical drop test vehicle was used. This 2000-lb vehicle could be loaded under the wing of a Navy A7 aircraft and dropped from 18,000 ft altitude.

Recovery System

The recovery system shown in Fig. 1 consists of a 15-ft-diam ribbon parachute reefed to 50% for 10 s and a 73-ft-diam paraform (cross) type second-stage parachute deployed 21 s after first-stage deployment. This parachute was reefed to 20% for 10 s.

Deployment Sequence

For the parachute development drop tests, a mechanical clock timer was used to deploy the parachute 2 s after release from the A7 aircraft at an altitude of 18,000 ft. Pullout wires extracted at release started the timer. The timer transmitted a 30-V signal to the pressure cartridges in the two six-ball thrusters located at the aft end of the vehicle. The 4.81-lb lid was ejected at 74 ft/s, deploying the reefed drogue chute.

The drogue loads were transmitted into the structure by a load plate which was held in the canister by a ball-locking mechanism. At the preset time (21 s), the mechanical timer fired the pyrotechnic pressure cartridges in two pin pushers. These unlocked the ball-locking mechanisms and released the load plate. The main canopy bag was attached to the load plate by a four-leg bridle.

For two ARIES rocket-launched operational flights, the deployment sequence was initiated after re-entry at Mach 7 by a barometric switch set to activate the same thrusters used for the drop tests and deploy the lid at 18,000 ft.

Results

Two successful drop tests of the final parachute system were conducted. The second test was a 20% overtest in dynamic pressure at lid fire and 12% in vehicle weight to qualify the recovery system for operational rocket flight. It should be noted that both chutes used in the first test were repacked and used on the second test without any damage.

Two operational recoveries of NASA telescope payloads were conducted successfully. Payload weights were 1600 and 2056 lb. The 44-in.-diam by 15.8-ft-long cylindrical payloads re-enter the atmosphere at about Mach 7 with the parachute compartment lid on the end of the payload facing the oncoming airflow. A cork insulating layer on the forward end of the payload was charred black from aerodynamic heating. The payloads were recovered undamaged with the impact velocity being approximately 30 ft/s.

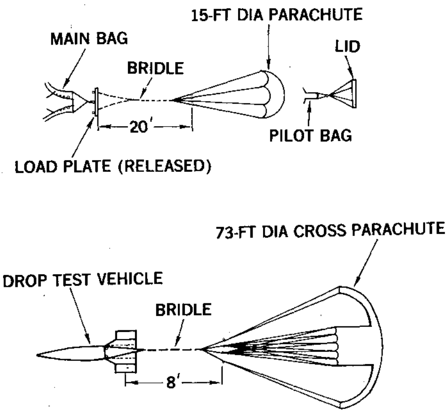

Fig. 1 Sketch of ARIES parachute system.

Received Oct. 14, 1981; presented as Paper 81-1949 at the AIAA 7th Aerodynamic Decelerator and Balloon Technology Conference, San Diego, Calif., Oct. 21-23, 1981; revision received Feb. 22, 1982. This paper is declared a work of the U.S. Government and therefore is in the public domain.

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Table 1 Operational drag area vs time

Event	Time, s	C_DS, ft^2
Lid fire	0	11.6
Line stretch	0.4	11.6
15 ft reefed	0.6	45.0
Reef cut	10.4	45.0
15 ft open	10.5	100.0
15 ft release	25.0	100.0
73 ft lines deploy	25.01	11.6
73 ft canopy stretch	25.8	11.6
Reef open	32.0	450.0
Reef cut	36.0	450.0
Full open	37.5	2250.0
To impact	1000.0	2250.0

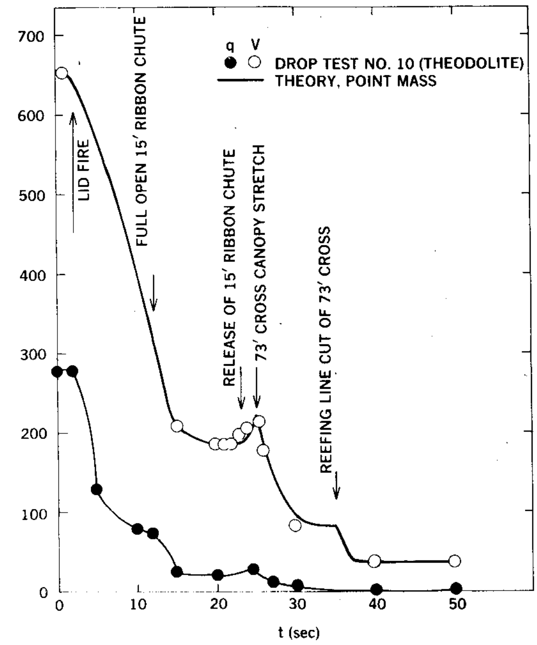

Fig. 2 Velocity and dynamic pressure decay with time after drop.

Analysis of Data

Theoretical point-mass trajectory calculations run on the CDC 7600 computer were used for all the tests. The drag-area variation with time listed in Table 1 was used. A typical comparison (Fig. 2) of theory (solid line) and theodolite tracking data (circles) velocity and dynamic pressure variation with time after release from the A7 aircraft shows excellent agreement for the last drop test.

Parachute peak loads were obtained from point mass theoretical trajectories. First stage suspension line peak load of about 8500 lb is well below the design allowable value of 16,000 lb. The weak link in the system is the two-ply 1.1-oz/yd^2 nylon cloth in the crown of the 73-ft cross. This material is subject to friction burning at the high bag strip velocities.

Conclusions

A series of ten drop tests was conducted to develop a two-stage parachute recovery system for the NASA ARIES space telescope research. The final system consists of a 15-ft-diam ribbon parachute reefed to 50% for 10 s and a 73-ft-diam cross or paraform reefed to 20% for 10 s. The following conclusions were reached: 1) The recovery system is qualified for a 2200-lb payload. 2) Two successful operational flights with recovery of 1600- and 2056-lb payloads were conducted at White Sands Missile Range.

Acknowledgments

The parachutes were rigged and packed by Horace Lucero and Alvin Oleson at the Sandia Parachute Laboratory. This work was supported by the U.S. Department of Energy and the National Aeronautics and Space Administration.

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AIAA 82-4165

STOL Aircraft Response to Turbulence Generated by a Tall Upwind Building

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Nomenclature

A, B, C	= constant system matrices
h	= height above ground level
h_G	= thickness of the planetary boundary layer
$H(t,t')$	= system state transition matrix
x_i	= position relative to the point where the glideslope intersects the runway
$R(t_1,t_2)$	= turbulence correlation matrix
$R_{W_iW_j}(\tau)$	= ijth element of $R(t_1,t_2)$
t	= time
t_i	= time at which aircraft reaches position x_i
W	= wind velocity
W_G	= wind velocity at the top of the planetary boundary layer
W	= turbulence velocity in the atmosphere
$(W_1 W_2)$	= the x and z components of W in an Earth-fixed reference frame
$\mathfrak{X}$	= vector with components X (column matrix)
X	= matrix
X^T	= transpose of X
$\langle x \rangle$	= expected value of x
$\bar{x}$	= mean value of $x(t)$
$\hat{x}$	= root mean square of $x(t)$
Δu	= aircraft's longitudinal airspeed perturbation
Δx	= aircraft state vector
τ	= time delay $(t_2 - t_1)$
$(\dot{\ })$	= d( )/dt

Introduction

THE prediction of aircraft response to wind shear and turbulence on the landing approach has been addressed by several authors recently. This has been prompted by the occurrence of a number of wind-related fatal accidents and by an interest in downtown STOLport operations. Several

Received Nov. 25, 1981; revision received March 8, 1982.

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