

**Technical Report Documentation Page**

1. Report No. <b>DOT/FAA/AM-96/25</b>		2. Government Accession No.		3. Recipient's Catalog No.	
4. Title and Subtitle <b>Survival at High Altitudes: Wheel-Well Passengers</b>				5. Report Date <b>October 1996</b>	
				6. Performing Organization Code	
7. Author(s) <b>S.J.H. Véronneau, MD, MS*; S.R. Mohler, MD, MA**; A.L. Pennybaker, BS*, B.C. Wilcox, BS*; and F. Sahiar, MD, MS</b>				8. Performing Organization Report No.	
9. Performing Organization Name and Address <b>*FAA Civil Aeromedical Institute P.O. Box 25082 Oklahoma City, OK 73125</b> <b>**Dept. of Community Health Wright State University Dayton, Ohio</b>				10. Work Unit No. (TRAVIS)	
				11. Contract or Grant No.	
12. Sponsoring Agency name and Address <b>Office of Aviation Medicine Federal Aviation Administration 800 Independence Ave., S.W. Washington, DC 20591</b>				13. Type of Report and Period Covered	
				14. Sponsoring Agency Code	
15. Supplemental Notes					
16. Abstract  Ten specific "wheel-well" passenger stowaway flights (the wheel-well area was entered just before takeoff) are documented in the <i>N.Y. Times</i> , covering the period 1947 to 1993. Five stowaways survived flights encompassing altitudes as high as 39,000 feet, with six dying in the process (one flight had two stowaways: one fatal, one surviving). Three Douglas DC-8 and four Boeing 707 aircraft, plus a Caravelle, an unknown jet, and a piston airliner were utilized. Several of the wheel well flight stowaways were reported to be politically motivated to attempt these international flights. This paper describes the unpressurized flight environment and the physiology that enabled human survival under conditions of extreme hypoxia and cold (inducing a virtual "hibernative" state). It is likely that similar attempts will continue, and alert airport security preventive measures are indicated.					
17. Key Words <b>High Altitude Survival Wheel-Well Stowaways Hypothermia, Hypoxia</b>			18. Distribution Statement <b>Document is available to the public through the National Technical Information Service Springfield, Virginia 22161</b>		
19. Security Classif. (of this report)  <b>Unclassified</b>		20. Security Classif. (of this page)  <b>Unclassified</b>		21. No. of Pages  <b>7</b>	22. Price

Form DOT F 1700.7 (8-72)  
authorized

Reproduction of completed page

## SURVIVAL AT HIGH ALTITUDES: WHEEL-WELL PASSENGERS

The *New York Times* cited 10 stowaway "wheel-well passenger" airline flights between 1947-1993, with five stowaways successfully completing their hazardous undertaking in unpressurized wheel-wells (6). Characteristics of these flights are shown in summary form in Table 1. The highest cruising altitude for a flight reported in this series was 39,000 feet. Douglas DC-8 and Boeing 707 aircraft were most commonly cited as choices. One flight had two stowaways, only one of whom survived (Flight No. 7).

The stated objective of the individuals who successfully made wheel-well flights was to escape the living circumstances in their home country (a not-liked political or economic environment), and to start a new life in a more desirable location. The vignette that generally describes the known cases involves the

individuals hiding near the point where the departing aircraft waited at the runway for take-off clearance. While the aircraft was stationary, the stowaways mounted, undetected, a main landing gear and climbed into a wing recess area adjacent to where the gear would retract (Figure 1).

Certain aircraft contain sufficient space in the landing gear area for a small adult to crawl into the space and hide relatively securely. The DC-8 has space above and forward of the right main landing gear strut (about 4' by 3½' by 3') to accommodate one (and even two) small adults, as shown in the reenactment by a Civil Aeromedical Medical Institute researcher (Figure 1). The comparable left main landing gear area of DC-8s contains hydraulic reservoirs and other space-utilizing items, precluding the use by stowaways.

**Table 1.**  
Ten Wheel-Well Stow-Away Flights  
Documented by the *New York Times*

N.Y. TIMES DATE	PERSON (YO = Years Old)	FROM	TO	AIRCRAFT	COMMENT
1. June 4, 1993	Male, 13 YO	Bogota	Miami	DC-8	35,000 ft. Covered in frost. Survived.
2. Nov. 14, 1986	Male, 35 YO	Panama City	Miami	707	39,000 ft. Survived.
3. March 23 1975	Unknown youth	Bogota	Miami	707	Fatal. Fell from aircraft.
4. April 14 1972	Male, 18 YO	San Diego	New York City	707	35,000 ft. Wheel-well, left wing. Fatal, Frozen.
5. Feb. 24, 1970	Male, 14 YO	Sydney, Australia	Tokyo	707	Fell 200 ft. on take-off from Sydney.
6. June 21, 1970	Male, 13 YO	Lyons, France	Abidjan	DC-8	Fatal. Fell at Abidjan when landing gear lowered.
7. July 26, 1969	Male, 17 YO (5'4", 135 lbs.). A 2nd unknown also climbed aboard.	Havana	Madrid	DC-8	29,000 ft. 1st survived. The 2nd fell to death.
8. April 19, 1966	Unknown youth. 20-21 YO	Orly	Morocco	Air France Caravelle	Right Wing. Fatal (frozen body).
9. Sept. 28, 1966	Male, 17 YO	Bogota	Mexico City	Colombian jet airliner.	34,000 ft. Survived.
10. Aug. 5, 1947	Male, 30 YO	Lisbon	Natal, Brazil	KLM piston airliner	Survived in wheelbase.

**Figure 1. Wheel-Well Passenger Stow-Away Space. it is forward of DC-8 Right Main Landing Gear, Wing Root Area.**



When the landing gear retracts in jet aircraft, metal covers close over the opening where the wheel and strut are positioned when the gear is extended, thus reducing in-flight air drag and further securing a stowaway.

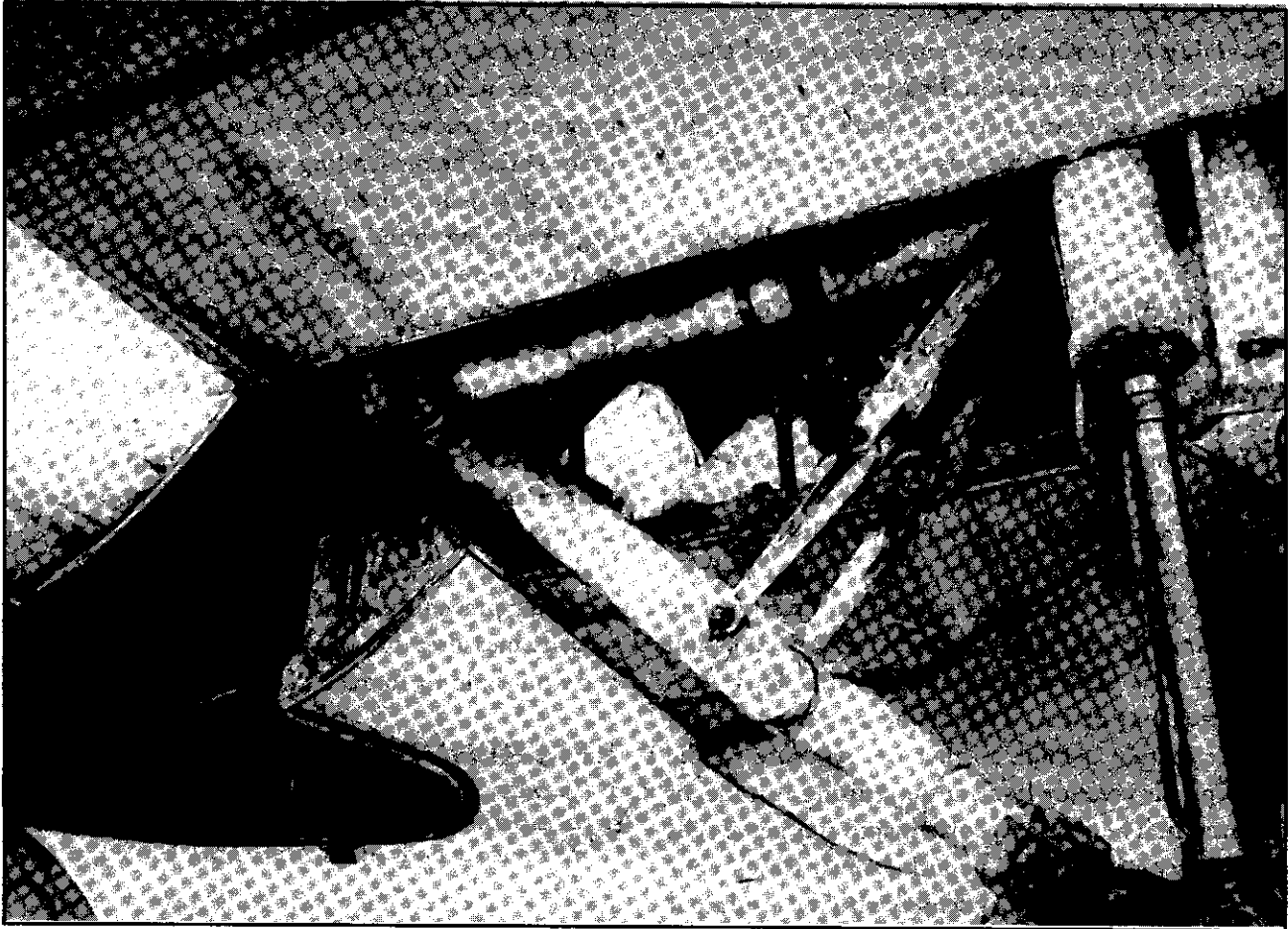
### **Physiological Considerations**

As the aircraft climbs to cruise altitude, the occupant of the unpressurized wheel-well compartment experiences a progressive "slow" hypoxia. Accompanying the climb is some friction heat generated within the tires during take-off that can radiate to the stowaway. Also, due to the warm hydraulic fluid in the lines within the wheel-well compartment, some addi-

tional radiant and conductive heat is present in the stowaway area. These heat sources are progressively diminished as flight at altitude proceeds.

As the aircraft with a stowaway climbs toward cruise altitude, the ambient atmospheric pressure and correlated physical characteristics will change approximately in accordance with Table 2. The "standard" ambient temperatures (in Centigrade) are calculated for 29,000 feet (-43° C), 34,000 feet (-53° C), 35,000 feet (-55° C), and 39,000 feet (-63° C), using the standard formula "double the first two numbers of altitude, subtract 15 and change the sign (5)." These are reported cruise altitudes of survived jet flights by wheel-well stowaways.

**Figure 2. DC-8 Wheel-Well Passenger Stow-Away Space. Re-enactment by CAMI Researcher.**



**Table 2. Approximate Environmental Characteristics in Accordance with Altitude.**

Altitude (x 10 <sup>3</sup> ft)	Pressure (mmHg)	O <sub>2</sub> Partial Pressure	Temperature °C
40	141	30	-65
30	226	47	-45
20	349	73	-25
10	523	110	-5
0	760	160	15

In addition to the drop in ambient altitude temperature (ameliorated somewhat by the above-cited radiation and conductive heat sources), Table 2 describes the decreasing partial pressure of oxygen (PPO<sub>2</sub>) with increasing altitude. At all cruising jet altitudes, the PPO<sub>2</sub> is below that required to support brain consciousness. All jet wheel-well stowaways at these cruise altitudes will lose consciousness from hypoxia.

In addition to experiencing the cold and hypoxia stressors, the stowaways are at high risk for nitrogen gas embolism and decompression sickness (DCS) above the 20,000 foot level.

Instances four and eight (Table 1) were both fatal and prominently cited as "frozen." Instance 1 (Table 1), a survivor, was described as "covered in frost" and suffering from frostbite, as were other survivors.

### Surviving Hypoxia, Low Temperature, and the Threat of Decompression Sickness

The five stowaway survivors were 13, 17, 17, 30, and 35 years of age. One was described as 64 in. tall and weighing 135 lb. (Table 1, Instance No. 7). A youthful, thin, non-exercising individual, is less likely to experience DCS than are heavy-set and older individuals (1, 3). The stowaways were reported in several write-ups as being "lightly clad" in a circumstance of poor thermal insulation that promotes heat loss in a cold environment.

Surviving severe hypoxia in the unpressurized wheelwells of cruising airline aircraft involves physiologic control mechanisms reviewed by Kalish (2) and Phythyon (4). These authors cite the homeothermic characteristic of humans whose usual healthy state maintains the body temperature between 36.0°C and 37.5°C. The resting metabolism in this body temperature range demands a baseline oxygen consumption level that cannot be met on exposure to the atmospheric pressure levels at the cruising altitudes of jet aircraft. The severe hypoxia inactivates nerve cells in the preoptic anterior hypothalamus, which contains the thermoregulatory center, with the result that heat loss and production in the body can no longer be controlled (2). Humans placed in an environment that overwhelms the thermoregulatory system of the body will become "poikilothermic," with the external environment driving body temperature. The establishment of a poikilothermic state is a basic mechanism invoked when hypothermia for surgical purposes is utilized. In the poikilothermic condition, a state somewhat reminiscent of hibernation occurs, during which the body's requirement for oxygen is greatly diminished. Body temperature in hypothermia can fall to levels of 27° C or lower. At the lower levels, unconsciousness, and lower heart and respiratory rates occur.

### Return to Ground Level

As a wheel-well stowaway is carried to lower altitudes, a gradual rewarming occurs, along with reoxygenation. If the individual is so fortunate as to avoid brain damage or death from the hypoxia and hypothermia, cardiac arrest or failure on rewarming, or severe neurovascular DCS complications, some progressive recovery of consciousness occurs, perhaps in the period before landing, or at a time after landing. Survival is jeopardized if the recovering stowaway begins moving round and falls out when the landing gear is lowered (example: Incident No. 6)

From time to time, a relatively young person attempts travel (almost invariably international travel) in a wheel-well of an airline aircraft. Some successful stowaway flights may be unknown, the travelers recovering at the destination with the help of "Good Samaritans." It is also likely that various unsuccessful attempts were never documented (or known), the bodies falling into an ocean, or into a remote land area. Key preventive measures are ramp security and security measures during taxi operations with pauses, and while holding for takeoff at the departure runway.

### REFERENCES

1. Gowdey, C.W., Philp, R.B. Etiology and treatment of experimental decompression sickness with special reference to body lipids. *Milit. Med.* 1965; 130: 648-652.
2. Kalish, N.A. Hypothermia and hyperthermia in trauma patients. In: Stene, J.K., Grande, C.M., (Eds.) *Trauma anesthesia*. Baltimore, Md. Williams and Wilkins, 1991: 340-367.
3. McCallum, R.I., Welder, D.N., and Thickett, V.B. Bone necrosis in commercial divers. *Undersea Biomed. Res.* 1976; 3: A.41.
4. Phythyon, J. Deep hypothermia and circulatory arrest. In: Kambam, J. *Cardiac anesthesia for infants and children*. St. Louis, Mo. Mosby, 1994: 33-38.
5. Taylor, R. *Fair weather flying*. New York: MacMillan, 1981:287.
6. *The New York Times*, Jun 4, 1993; Nov 14, 1986; Mar 23, 1975; Apr 14, 1972; Jun 21, 1970; Feb 24, 1970; Jul 26, 1969; Apr 19, 1966; Sep 28, 1966; Aug 5, 1947.