



Quantifying Costs of Turbulence Avoidance & Encounters

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Costs of Avoidance

During Preflight Route Selection

Avoidance implies off optimum route &/or altitude.

Resulting in:

- Added Fuel Burn
- Added Time En Route

En Route Adjustments

- Altitude “porpoising”
- Unplanned route deviations & fuel burn

Anecdotal Info: 15 Oct 2012 – Avoiding Severe Turbc over North Atlantic

Cost & Risk of Encounters

Empirical Data

- Flight Attendant Injuries
 - Average Annual Lost Time Costs per Flight Attendant
 - Annual Average for 1991-2007: \$11,229
 - Highest (2005) Annual Ave: \$26,546
 - Lowest (1992) Annual Ave: \$ 5,694
 - Actual Annual Claim Costs due to Lost Time
 - Annual Average for 1991-2007: \$ 580K
 - Highest (2005) Annual Cost: \$1,248K
 - Lowest (2001) Annual Cost: \$ 284K
 - Risk of Lost Time Claims per 1M En Route Hours flown
 - Annual Average Claims 1991-2007: 48.4
 - Highest (2006) Claims: 70.5
 - Lowest (2000) Claims: 35.2
 - Risk of Lost Time per month of Year (2009-2011)
 - Highest Risk month = June
 - Highest Risk period = Apr-July
 - Lowest Risk Month = Sept
 - Lowest Risk period = Sept-Nov

Empirical approach w/ other risks: Passenger Injuries, Aircraft Damage & Inspections

Example

- **ECONOMIC VALUES FOR FAA INVESTMENT AND REGULATORY DECISIONS, A GUIDE**
 - DRAFT FINAL REPORT, December 31, 2004
 - Prepared for: FAA Office of Aviation Policy & Plans
 - Prepared by: GRA, Incorporated, *Economic Counsel to the Transportation Industry*
 - Section 2: Treatment of the Values of Life & Injury in Economic Analysis

Economic Values

Definition of Injuries

Table 2-1: Selected Sample of Injuries by the Abbreviated Injury Scale (AIS)

AIS Code	Injury Severity Level	Selected Injuries
1	Minor	Superficial abrasion or laceration of skin; digit sprain; first-degree burn; head trauma with headache or dizziness (no other neurological signs).
2	Moderate	Major abrasion or laceration of skin; cerebral concussion (unconscious less than 15 minutes); finger or toe crush/amputation; closed pelvic fracture with or without dislocation.
3	Serious	Major nerve laceration; multiple rib fracture (but without flail chest); abdominal organ contusion; hand, foot, or arm crush/amputation.
4	Severe	Spleen rupture; leg crush; chest-wall perforation; cerebral concussion with other neurological signs (unconscious less than 24 hours).
5	Critical	Spinal cord injury (with cord transection); extensive second- or third-degree burns; cerebral concussion with severe neurological signs (unconscious more than 24 hours).
6	Fatal	Injuries, which although not fatal within the first 30 days after an accident, ultimately result in death.

Willingness to Pay (WTP) by Society for Reduced Risk

**Table 2-2: WTP Values Per AIS Injury Level
(2001 dollars)**

AIS Code	Description of Injury	Fraction of WTP Value of Life	WTP Value
AIS 1	Minor	0.20%	\$6,000
AIS 2	Moderate	1.55%	\$46,500
AIS 3	Serious	5.75%	\$172,500
AIS 4	Severe	18.75%	\$562,500
AIS 5	Critical	76.25%	\$2,287,500
AIS 6	Fatal	100.00%	\$3,000,000

**Table 2-3: Per Victim Medical and Legal Costs Associated with Injuries
(2001 dollars)**

AIS Code	Description of Maximum Injury	Emergency/ Medical	Legal/Court	Total Direct Costs
AIS 1	Minor	\$600	\$1,900	\$2,500
AIS 2	Moderate	\$4,000	\$3,100	\$7,100
AIS 3	Serious	\$16,500	\$4,700	\$21,200
AIS 4	Severe	\$72,500	\$39,100	\$111,600
AIS 5	Critical	\$219,900	\$80,100	\$300,000
AIS 6	Fatal	\$52,600	\$80,100	\$132,700

Source: Economic Values for Evaluation of Federal Aviation Administration Investment and Regulatory Programs, FAA-APO-89-10, October 1989, Section 3, as adjusted for price level changes.