
Laser beam encounter, Boeing 737-5H4, October 30, 1995

Micro-summary: This Boeing 737-5H4 was climbing when the first officer was hit in the eye by an entertainment laser from the ground.

Event Date: 1995-10-30 at 1810 PST

Investigative Body: National Transportation Safety Board (NTSB), USA

Investigative Body's Web Site: <http://www.nts.gov/>

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 National Transportation Safety Board FACTUAL REPORT AVIATION		NTSB ID: LAX961A032		Aircraft Registration Number: N508SW	
		Occurrence Date: 10/30/1995		Most Critical Injury: Minor	
		Occurrence Type: Incident		Investigated By: NTSB	
Location/Time					
Nearest City/Place LAS VEGAS		State NV	Zip Code 89119	Local Time 1810	Time Zone PST
Airport Proximity: Off Airport/Airstrip		Distance From Landing Facility: 1		Direction From Airport: 260	
Aircraft Information Summary					
Aircraft Manufacturer Boeing		Model/Series 737-5H4		Type of Aircraft Airplane	
Sightseeing Flight: No			Air Medical Transport Flight: No		
Narrative					
Brief narrative statement of facts, conditions and circumstances pertinent to the accident/incident:					
<p>On October 30, 1995, at 1810 hours Pacific standard time, the first officer on Southwest Airlines flight 1367 sustained an eye injury when he was struck by what is believed to be a laser beam during departure from Las Vegas, Nevada. The aircraft, a Boeing 737-5H4, N508SW, was operated by Southwest Airlines, Inc., as a regularly scheduled domestic passenger flight from Las Vegas to San Antonio, Texas. Visual meteorological conditions prevailed. The aircraft was not damaged and there were no injuries to the passengers or other crew members.</p>					
<p>The crew stated that the aircraft departed runway 25 at the Las Vegas airport at 1808 and was climbing through 7,000 feet msl (about 4,500 feet agl) on a standard instrument departure route when the incident occurred. The first officer, who was the flying pilot, said a laser beam swept past the cockpit from his left to right and he immediately experienced eye pain and was completely blinded in the right eye. He stated that the beam seemed to come from a point about 2 o'clock low reference his visual focus, which was on the flight instruments. After image effects also induced a blind condition in his left eye. He reported that the total inability to see lasted 30 seconds, and for an additional 2 minutes, he could not focus on or interpret any instrument indications. In addition to the vision problems, the pilot said that for several minutes he was completely disoriented in his spatial relationship to the vertical. The captain was not irradiated by the beam and was able to assume control of the aircraft and continue the climb.</p>					
<p>Many of the larger hotels in Las Vegas have some sort of outdoor laser light show or demonstration. Most of these installations have both fixed/stationary (static) beams of relatively high power and "dancing" beams of lower power, which flash about the sky in irregular patterns. The majority of the hotels with "dancing beam" shows have voluntarily placed some azimuth and elevation limits to the beam travel in response to the on-going insistence of the Clark County airport officials and the Las Vegas area ATC management. The laser apparatus in use by the hotels can be adjusted in both power output and beam divergence angles and none has devices which record the parameters emitted or times of equipment operation. Some of the hotels have elected to terminate their laser output against walls or other hard obstructions.</p>					
<p>Recorded radar data was obtained from the FAA Las Vegas TRACON depicting the aircraft's flight and altitude track from takeoff until reaching 14,000 feet msl. The data was provided to the Safety Board's Office of Research and Engineering, which performed a trajectory and vehicle attitude study to determine the relative position of several resorts with laser shows to the position and orientation of the aircraft during its ascent. The radar data study is appended to this report.</p>					
<p>A review of the air-to-ground communications between the aircraft and Las Vegas TRACON revealed that a routine exchange was conducted at 1811:35. At 1811:51, the crew transmitted, "We like to report a strike by that laser beam climbing out of seven thousand directly into the cockpit." Correlation of the radio transmission times to the recorded radar data reveals that at 1811:35, the aircraft was reporting a mode C altitude of 6,800 feet. Around 1811:51, the mode C report from the</p>					
FACTUAL REPORT - AVIATION					
Page 1					

 <p>National Transportation Safety Board FACTUAL REPORT AVIATION</p>	NTSB ID: LAX96IA032
	Occurrence Date: 10/30/1995
	Occurrence Type: Incident

Narrative (Continued)

aircraft was between 7,500 and 7,800 feet.

The radar data showed that the aircraft departed runway 25 in a westerly direction and performed a right turn in accordance with the Mead Eight Departure to a 070-degree heading while climbing to 14,000 feet. According to flight crew statements, the laser beam encounter occurred at or slightly before the aircraft passed through 7,000 feet msl (about 4,500 feet above ground) in the climb. The trajectory and vehicle attitude studies show that as the aircraft passed through 7,000 feet, the positions of several resorts relative to the aircraft were all located in the clear vision field of view of the first officer, as defined by SAE Aerospace Standard 580B. Three of the resorts (Rio, Hilton, and Stratosphere) were at a position of less than 90 degrees relative azimuth from the first officer's eye reference point. Relative position calculations show that of the three resorts at a relative azimuth of less than 90 degrees, the Rio had the shortest three dimensional distance to the aircraft at 4.7 nautical miles. The Hilton and Stratosphere were at three dimensional distances of about 7 nautical miles.

The FAA Las Vegas Air Traffic Hub facility maintains a log of laser activity by the known hotel emitters which is based wholly on self reports by the hotels of their activity. The Hilton Hotel reported their "Lumenaria" display (dancing beams) was turned on at 1810 on October 30th and turned off at 0200 on the 31st. The Luxor hotel reported their laser show was shut down for technical enhancements during the entire evening of the 30th. All other hotel displays were reported as operational at the time of the incident.

During the investigation, Safety Board investigators met in Las Vegas with the Society of Automotive Engineers (SAE) G-10 laser subcommittee. The subcommittee is currently helping the FAA to formulate guidelines for approval of outdoor laser light shows and related airspace compatibility issues. In addition to the SAE committee members, representatives from FAA Air Traffic (both headquarters and the Las Vegas facilities), FAA Flight Standards, Food and Drug Administration, U.S. Air Force, Clark County (both airport officials and local police agencies), several laser manufacturers and one of the hotels conducting laser shows were in attendance. In addition, the irradiated pilot and several management officials from Southwest Airlines were present.

A general briefing was conducted by the G-10 committee on the history of this problem, the work done to date with the FAA to formulate airspace compatibility guidelines and a technical overview of lasers and their hazards. Following this, the irradiated pilot gave a first hand account of his experience. A videotape made by the Las Vegas Police air unit graphically depicted several laser beam encounters. For example, one static beam from the Hilton Hotel produces a 60-foot diameter circle of light on a mountain 12.5 miles away, with a clearly defined silhouette of the helicopter visible within the circle. The police pilot who flew the mission stated that at 10 miles, looking at the beam is "like looking directly into the sun." According to the pilot descriptions of encounters, in the clear air around Las Vegas the beams are largely invisible from the air until they are suddenly encountered.

At the meeting, a list (appended to this report) of 51 prior aircraft/pilot laser irradiations over the past 2 years in the Las Vegas area was presented by the airport authority and the local air traffic facility. The Air Force representatives from Nellis AFB indicated that an equal number of events have happened to their pilots in the area. Subsequent contacts with other air carriers and military authorities have revealed incidents in Miami, Orlando, New York, Los Angeles, Mississippi, and along the Mississippi river near the Tennessee border. To date, no known permanent eye damage has resulted from an in-flight non-military laser irradiation event. According to aircrew reports, the encounters have so far consisted of everything from various levels of annoyance to startle and flash blindness effects to one or more members of the reporting crew. Several reports were noted of air carrier/military aircraft in cruise flight well above 30,000 feet encountering laser beams from Las Vegas which brightly illuminated the cockpits. Several air carrier and military pilots interviewed during this investigation stated their reluctance to officially report laser

National Transportation Safety Board

FACTUAL REPORT

AVIATION

NTSB ID: LAX96IA032

Occurrence Date: 10/30/1995

Occurrence Type: Incident

Narrative (Continued)

irradiation incidents for fear of potential problems with their medical certificates.

From a regulatory and licensing standpoint, the U.S. Food and Drug Administration, Center for Devices and Radiological Health, is currently the agency responsible for approving and regulating lasers used for entertainment and other displays. This is an outgrowth of the FDA's role in regulating lasers used in medical applications. An FDA representative stated that there are currently 200 active licenses for outdoor entertainment laser displays and the number is growing at an exponential rate. The FDA estimates there are over 1,200 laser manufacturers. The FDA representative to the Las Vegas meeting stated that outdoor entertainment laser displays have replaced search lights as the medium of choice for nearly everything from advertisements and store grand openings, to rock concerts and theme park entertainment shows. During the licensing application process, the FDA asks the FAA if they have any airspace compatibility objection to an outdoor laser display. The FAA must then say yes or no to the proposed license.

Chapter 34 of FAA Order 7400.2D in effect at the time of this incident contains guidelines for FAA personnel in the approval process for determination of whether a proposed outdoor laser light display is compatible with navigable airspace. The order defines two areas based in part on federal OSHA and FDA guidelines, the Nominal Ocular Hazard Distance (NOHD) and the Eye Safe Distance (ESD). NOHD is defined as the distance from the point source where the irradiance level in power and area footprint can cause permanent thermal damage to the retina. ESD encompasses all other irradiance exposures where biological damage to the eye should not occur. Approval requires only that the laser beam be classed as ESD in navigable airspace. The approval process does not consider such laser exposure effects as flashblindness, afterimage, startle and high glare conditions on pilot performance.

The U.S. Air Force Armstrong Lab at Brooks AFB is the current focal point for a combined military service research project into the effects on pilot performance of laser irradiations and are the acknowledged experts in this field. The Lab's research was used by the FAA as the basis for a proposed change to FAA Order 7400.2D (Procedures for Handling Airspace Matters), which provides guidance to FAA air traffic and flight standards personnel for the approval of outdoor laser light shows which may affect navigable airspace. The Lab's representative stated, however, that based on actual irradiation exposure events reported by civil and military pilots the lab has serious concerns that the controlled research studies to date adequately correlate to the real world.

The proposed changes to FAA Order 7400.2D establishes protected airspace areas around airports and specifies maximum allowable laser irradiance levels for each area. In the case of the incident airplane, it was in a "Critical Flight Zone." The proposed order establishes a maximum beam power/radiation level of 5 micro watts per square centimeter in this area. Based on the radar data track and the irradiated pilot's reconstruction of where his aircraft was at the time of the encounter, specialists from Armstrong Lab calculated that the beam was most likely one of the "dancing beams" from the Hilton Hotel. Assuming that the Hilton provided the accurate laser power level and beam divergence in use at the time, the lab calculated that the maximum exposure to the pilot would have been slightly under 1 micro watt per square centimeter at the point of encounter. According to the lab, the pilot's actual experience at the calculated power level was not at all predicted by the lab's research to date.

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Landing Facility/Approach Information						
Airport Name MCCARRAN INTERNATIONAL		Airport ID: LAS	Airport Elevation Ft. MSL	Runway Used 0	Runway Length	Runway Width
Runway Surface Type:						
Runway Surface Condition:						
Type Instrument Approach: NONE						
VFR Approach/Landing: None						
Aircraft Information						
Aircraft Manufacturer Boeing		Model/Series 737-5H4		Serial Number 24185		
Airworthiness Certificate(s): Transport						
Landing Gear Type: Retractable - Tricycle						
Homebuilt Aircraft? No		Number of Seats: 124	Certified Max Gross Wt. 120500 LBS		Number of Engines: 2	
Engine Type: Turbo Fan		Engine Manufacturer: Cfm		Model/Series: CFM56	Rated Power: 20500 LBS	
- Aircraft Inspection Information						
Type of Last Inspection Continuous Airworthiness		Date of Last Inspection	Time Since Last Inspection Hours		Airframe Total Time Hours	
- Emergency Locator Transmitter (ELT) Information						
ELT Installed? Yes		ELT Operated? No		ELT Aided in Locating Accident Site?		
Owner/Operator Information						
Registered Aircraft Owner FLEET NATIONAL BANK TRUSTEE		Street Address 777 MAIN STREET				
		City HARTFORD		State CT	Zip Code 06115	
Operator of Aircraft SOUTHWEST AIRLINES, INC.		Street Address P.O. BOX 36611				
		City DALLAS		State TX	Zip Code 75235	
Operator Does Business As:				Operator Designator Code: SWAA		
- Type of U.S. Certificate(s) Held:						
Air Carrier Operating Certificate(s): Flag Carrier/Domestic						
Operating Certificate:			Operator Certificate:			
Regulation Flight Conducted Under: Part 121: Air Carrier						
Type of Flight Operation Conducted: Scheduled; Domestic; Passenger Only						

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First Pilot Information

Name On File	City On File	State On File	Date of Birth On File	Age 43
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Sex: M	Seat Occupied: Left	Principal Profession: Civilian Pilot	Certificate Number: On File
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Certificate(s): Airline Transport; Flight Instructor

Airplane Rating(s): Multi-engine Land; Single-engine Land

Rotorcraft/Glider/LTA: None

Instrument Rating(s): Airplane

Instructor Rating(s): Airplane Single-engine

Type Rating/Endorsement for Accident/Incident Aircraft? Yes	Current Biennial Flight Review?
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Medical Cert.: Class 1	Medical Cert. Status: Valid Medical--no waivers/lim.	Date of Last Medical Exam: 07/1996
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- Flight Time Matrix	All A/C	This Make and Model	Airplane Single Engine	Airplane Multi-Engine	Night	Instrument		Rotorcraft	Glider	Lighter Than Air
						Actual	Simulated			
Total Time										
Pilot In Command(PIC)	7500	6500	100	7400	3000					
Instructor										
Last 90 Days	250	250		250	50					
Last 30 Days	90	90		90	20					
Last 24 Hours	7	7		7	2					

Seatbelt Used? Yes	Shoulder Harness Used? Yes	Toxicology Performed? No	Second Pilot? Yes
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Flight Plan/Itinerary

Type of Flight Plan Filed: IFR

Departure Point Same as Accident/Incident Location	State	Airport Identifier LAS	Departure Time 1808	Time Zone PST
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Destination SAN ANTONIO	State TX	Airport Identifier SAT	
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Type of Clearance: IFR

Type of Airspace: Class B

Weather Information

Source of Briefing: Company

Method of Briefing:

 <p>National Transportation Safety Board FACTUAL REPORT AVIATION</p>	NTSB ID: LAX96IA032
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Weather Information					
WOF ID	Observation Time	Time Zone	WOF Elevation	WOF Distance From Accident Site	Direction From Accident Site
LAS	1800	PDT	2179 Ft. MSL	1 NM	80 Deg. Mag.
Sky/Lowest Cloud Condition: Clear			0 Ft. AGL	Condition of Light: Night/Dark	
Lowest Ceiling: None		0 Ft. AGL		Visibility: 50 SM	Altimeter: 29.00 "Hg
Temperature: 19 °C	Dew Point: 8 °C	Wind Direction: 180		Density Altitude: Ft.	
Wind Speed: 5	Gusts:	Weather Conditions at Accident Site: Visual Conditions			
Visibility (RVR): 0 Ft.	Visibility (RVV) 0 SM	Intensity of Precipitation: Unknown			
Restrictions to Visibility: None					
Type of Precipitation: None					

Accident Information		
Aircraft Damage: None	Aircraft Fire: None	Aircraft Explosion: None

Classification: U.S. Registered/U.S. Soil					
- Injury Summary Matrix	Fatal	Serious	Minor	None	TOTAL
First Pilot				1	1
Second Pilot			1		1
Student Pilot					
Flight Instructor					
Check Pilot					
Flight Engineer					
Cabin Attendants				3	3
Other Crew					
Passengers				92	92
- TOTAL ABOARD -			1	96	97
Other Ground	0	0	0		0
- GRAND TOTAL -	0	0	1	96	97

National Transportation Safety Board

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Administrative Information

Investigator-In-Charge (IIC)

JEFF RICH

Additional Persons Participating in This Accident/Incident Investigation:

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LAS VEGAS, NV 89119