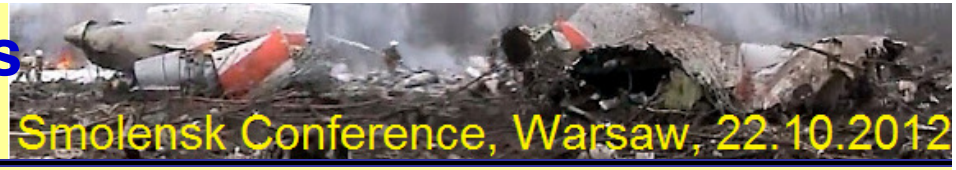
HYPOTHETICAL COLLISION OF TU-154M WITH BIRCH TREE VERSUS FULL-SCALE CRASH DYNAMIC TESTS OF DC-7 AND LC-1649

Porownanie hipotetycznej kolizji Tu-154M z brzoza z testami dynamicznymi zderzen w pelnej skali przy uzyciu samolotow DC-7 oraz LC-1649

Professor **Jacek F. Gieras**, PhD, DSc, Fellow IEEE
University of Technology and Life Sciences, Bydgoszcz, Poland

E-mail: jacek.gieras@utp.edu.pl

Full-Scale Crash Dynamic Tests of DC-7 and LC-1649



What?

Full-scale dynamic crash tests of DC-7 and Lockheed Constellation 1649 (LC-1649) passenger aircraft conducted by the Federal Aviation Agency in April 1964.

Why?

These test programs were designed to simulate typical crash conditions during survivable take-off and landing accidents and collected considerable data on crash loads, accelerations, and fuel containment.

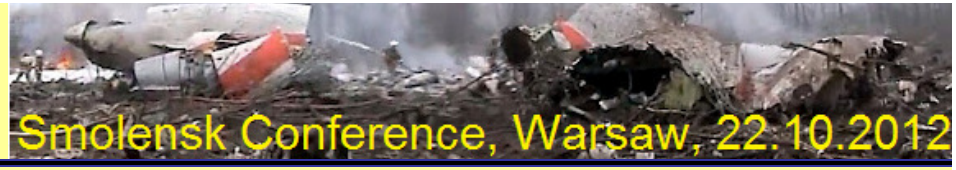
How ?

The test site has been designed in such a way as to obtain the desired impact conditions for accelerating the test aicraft to approximately the climbout velocity, controlled guidance of the aircraft to the initial impact point, and appropriate loacation of earthen barriers and pole barriers (telephone poles).

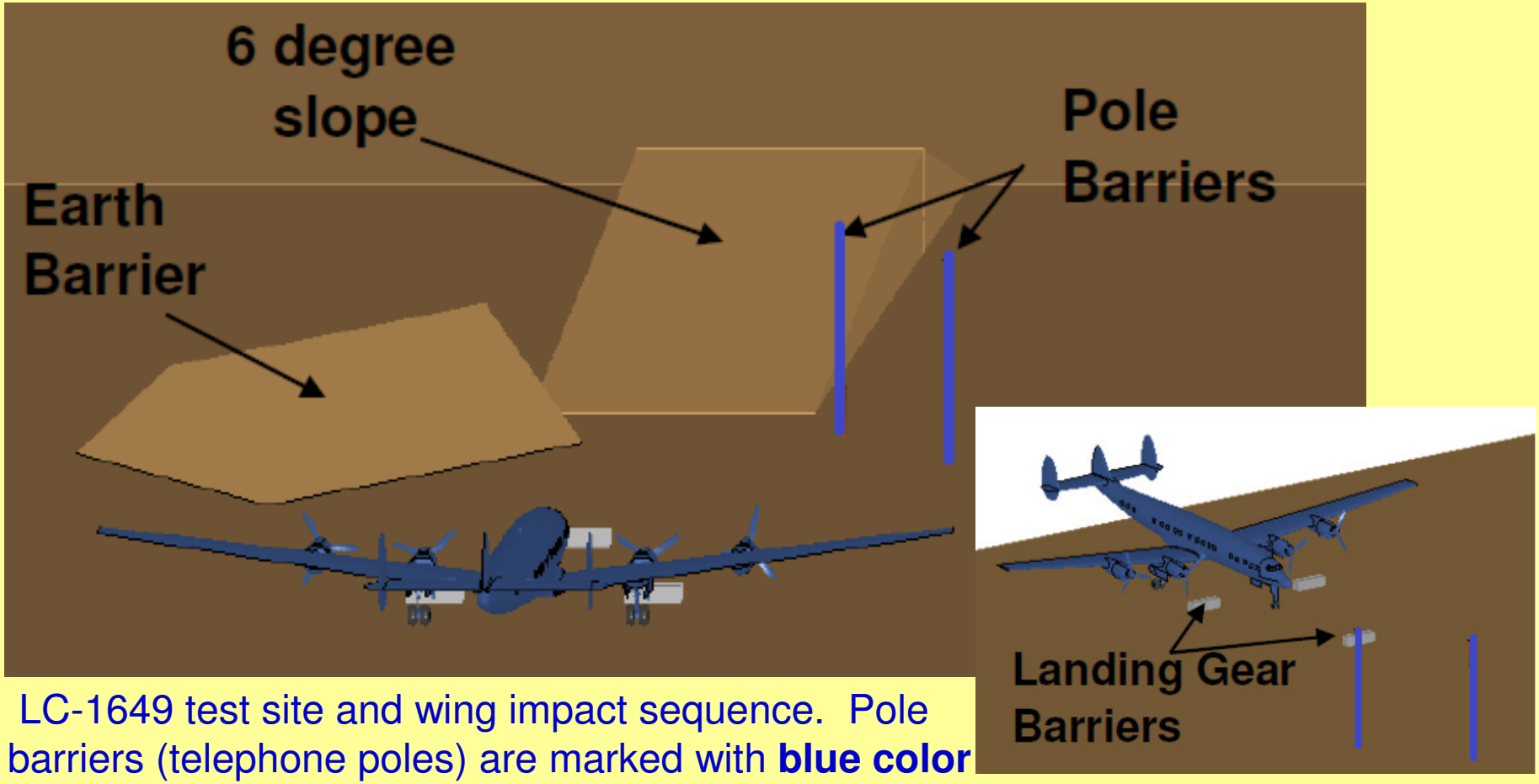
The runway was built of two soil-cement strips 4.57-m wide and 5.49-m apart laid over the desert soil to support the main landing gear wheels. The length of strips from release point to the impact barriers was 1219 m. The aircraft was guided along a single track made of standard 41-kg railroad rails laid on a continuous reinforced concreate base.

The rock, earthen and pole barriers were errected to break the nose landing gear, propellers of engines and wings, repectively.

LC-1649 full-scale dynamic crash test



In 1964 full-scale dynamic crash tests on DC-7 and Lockheed 1649 Constellation (LC-1649) were performed by the Federal Aviation Agency, AZ, USA

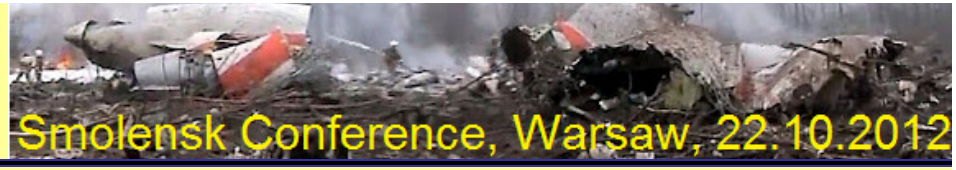


LC-1649 test site and wing impact sequence. Pole barriers (telephone poles) are marked with **blue color**

Test site: Deer Valley Airport north of Phoenix, AZ, USA

R. T. Bocchieri, et.al, Crash Simulation of Transport Aircraft for Predicting Fuel Release, FAA Worldwide Techn. Transfer Conf. Atlantic City, NJ, , 2010

How have been full-scale crash tests performed?



The **objective** of these experiments was *exploration of the manner in which large aircraft are damaged in survivable accidents and accurate measurement of the crash loads*

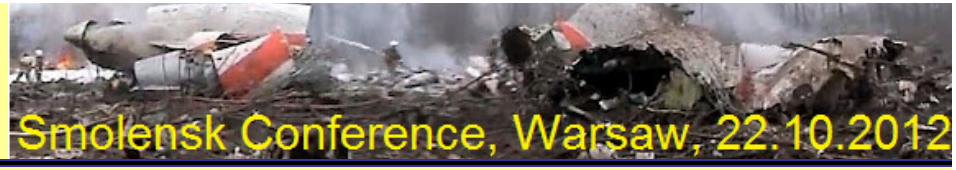
In the case of the DC-7, after collision with telephone poles, the tip of right wing finally fell off. **This fact is frequently cited by supporters of the crash official reports as a proof that the collision of the Tu-154M No 101 with the trunk of a birch tree on April 10, 2010 near Smolensk North Military Air Base severed the tip of the left wing** and finally caused fatal collision of theTu-154M No 101 with the ground.

It is necessary to point out the following **differences** in:

- **weight** and **volume** envelope of the Tu-154M, DC-7 and LC-1649 aircraft;
- **construction** of aircraft and their wings;
- **kinetic energy** and linear **momentum** of aircraft
- **height** at which the wing hit the pole or tree;
- **properties** of timber/wood;
- how the telephone poles and birch tree have been **anchored to the ground**.

W.H. Reed, S.H. Robertson, L.W.T. Weinberg, L.H. Tyndall, "Full-scale dynamic crash test of a Douglas DC-7 aircraft", Technical report FAA-ADS-37, Aviation Safety Engineering and Research, Phoenix, AZ, 1965.
W.H. Reed, S.H. Robertson, L.W.T. Weinberg, L.H. Tyndall, "Full-scale dynamic crash test of a Lockheed Constellation model 1649 aircraft, Technical report FAA-ADS-38", Aviation Safety Engineering and Research, Phoenix, AZ, 1965

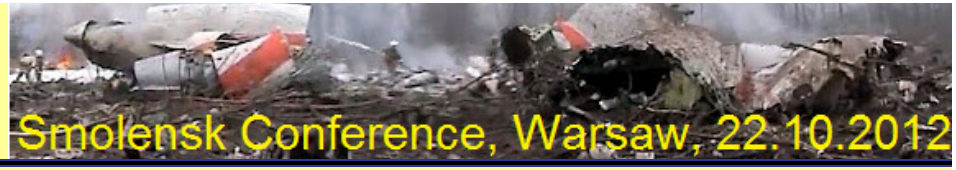
Full-Scale Tests



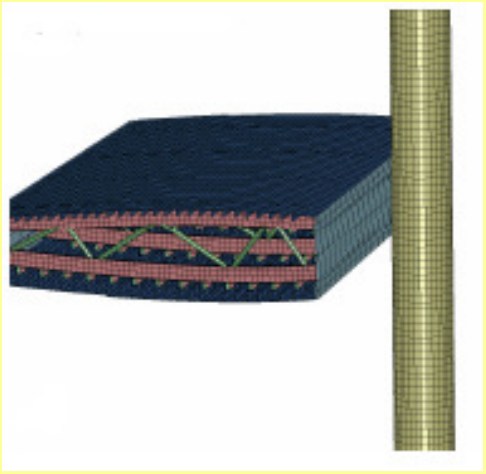
Conditions prior to crash or full-scale tests

Parameter	Tu-154M 101	DC-7	LC-1649
Gross weight of airliner at the time of crash/test. kg	78,600 (estimated)	49,010]	72,245
Velocity prior to contact with barrier, km/h	approx. 270.0 (birch tree)	257.4 (gear barrier)	207.6 (gear barrier)
Linear momentum, MNs	5.896	3.504	4.166
Kinetic energy, MJ	**221.1**	**125.3**	**120.1**
Leading edge sweep of wings, degree	approx. 37	approx. 5	approx. 6
Material of wooden barriers	birch tree	processed pine	processed pine
Height of impact point measured from the ground level, m	approx. 5.1	approx. 3.2	approx. 2.0
Diameter of pole/tree, m	0.3 to 0.4	0.305	0.305
Distance of impact point measured from the center axis of the fuselage, m	12.675	13.83	unknown
Wing sweep angle, degree	**37**	**5**	**6**
Length of the tip wing being cut off, m	6.1	3.66	unknown

LC-1649 full-scale dynamic crash test



Outboard pole impact

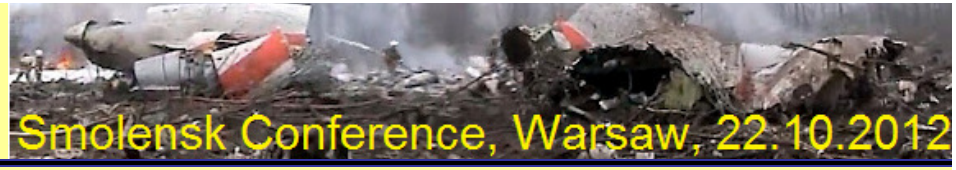


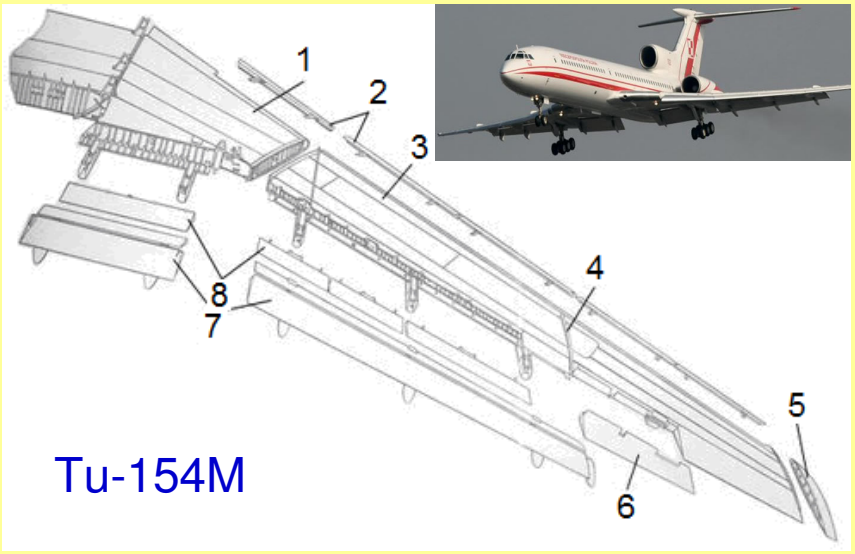
Inboard pole impact

The LC-1649 was made from higher-strength, low-elongation aluminum similar to modern aircraft.

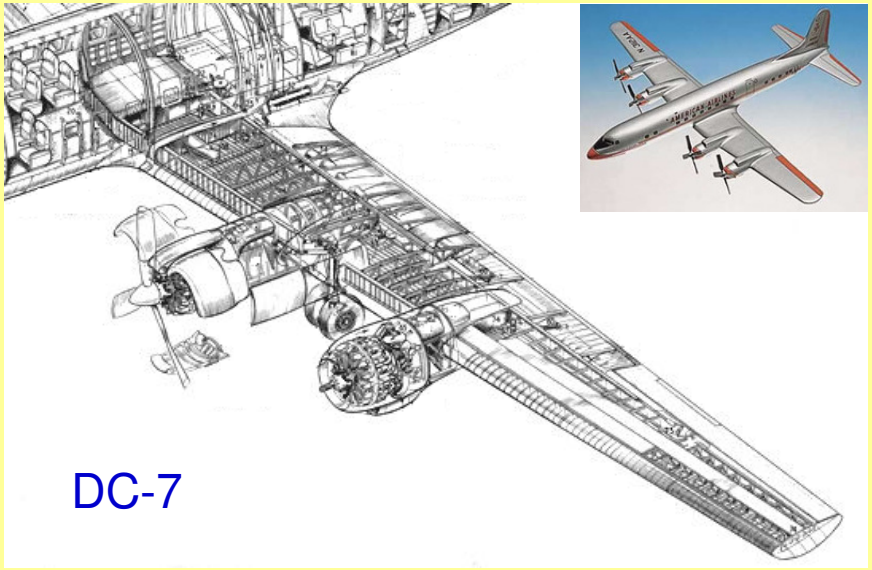
R. T. Bocchieri, et.al, Crash Simulation of Transport Aircraft for Predicting Fuel Release, FAA Worldwide Techn. Transfer Conf. Atlantic City, NJ, , 2010

Construction of Wings

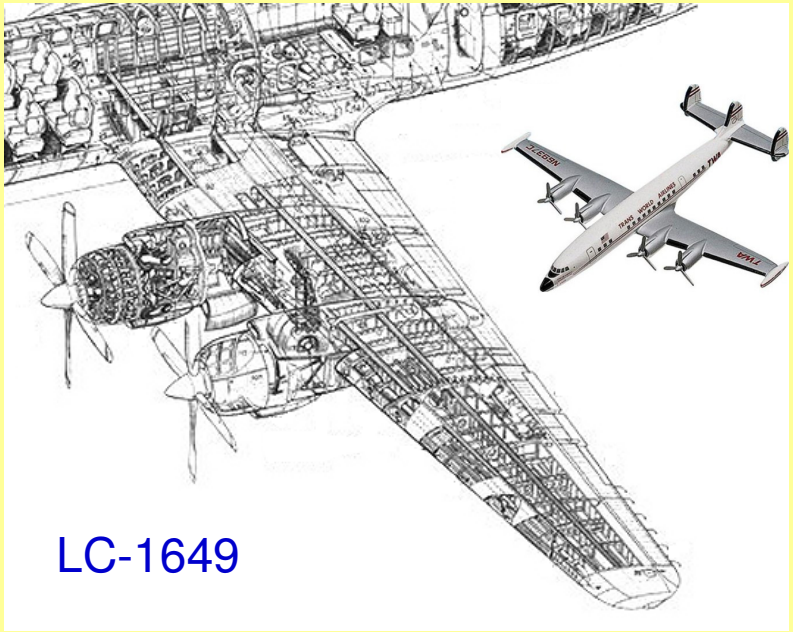




Tu-154M



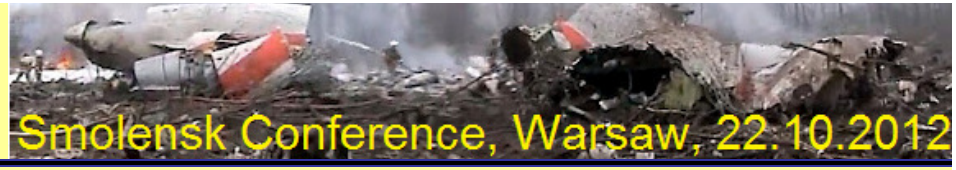
DC-7



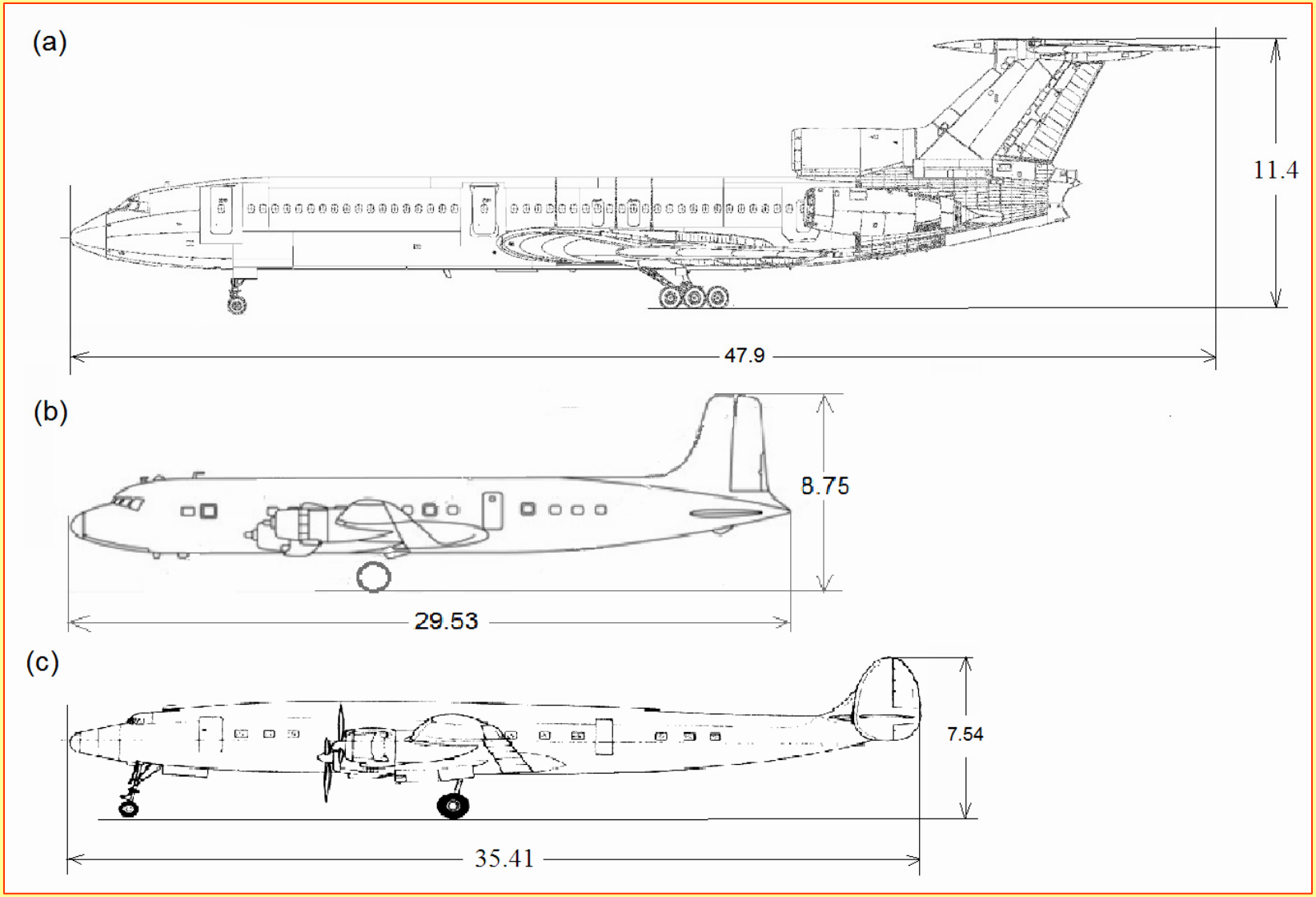
LC-1649

The first version of the **Tu-154M** was designed in 1964, while the **DC-7** was designed before 1953 and **LC-1649** before 1943. The **turbofan** engines of the **Tu-154M** are mounted in the rear of the fuselage. The **piston engines** of the **DC-7** and **LC-1649** are buried in wings

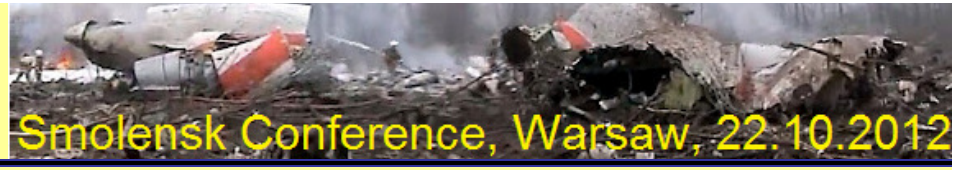
Length of Aircraft



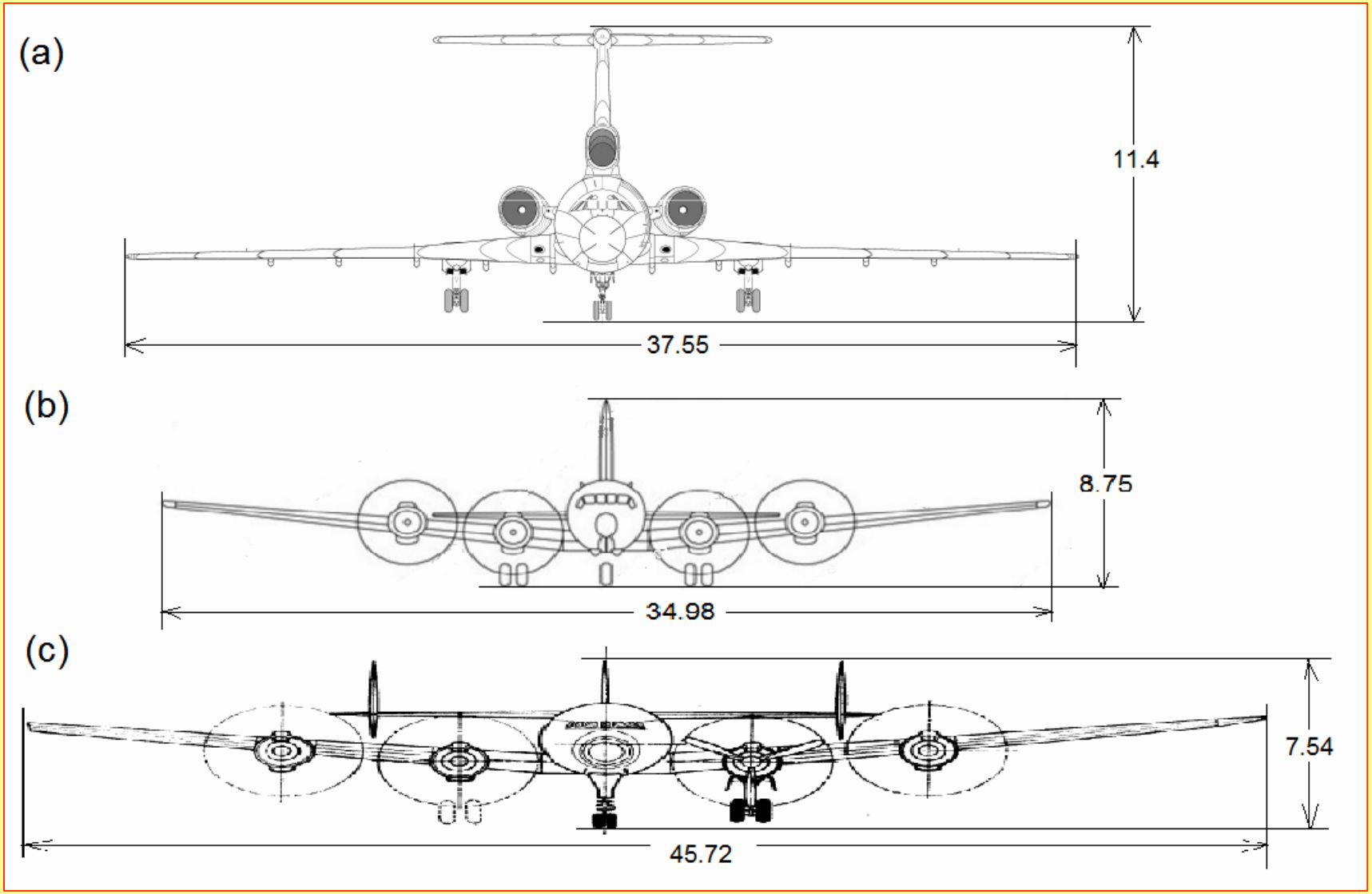
Comparison of length of aircraft: (a) **Tu-154M**; (b) **DC-7**; (c) **LC-1649**



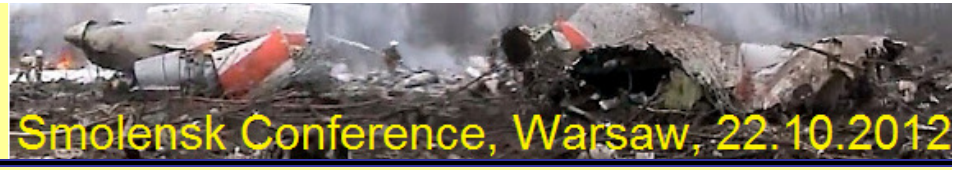
Wing Span of Aircraft



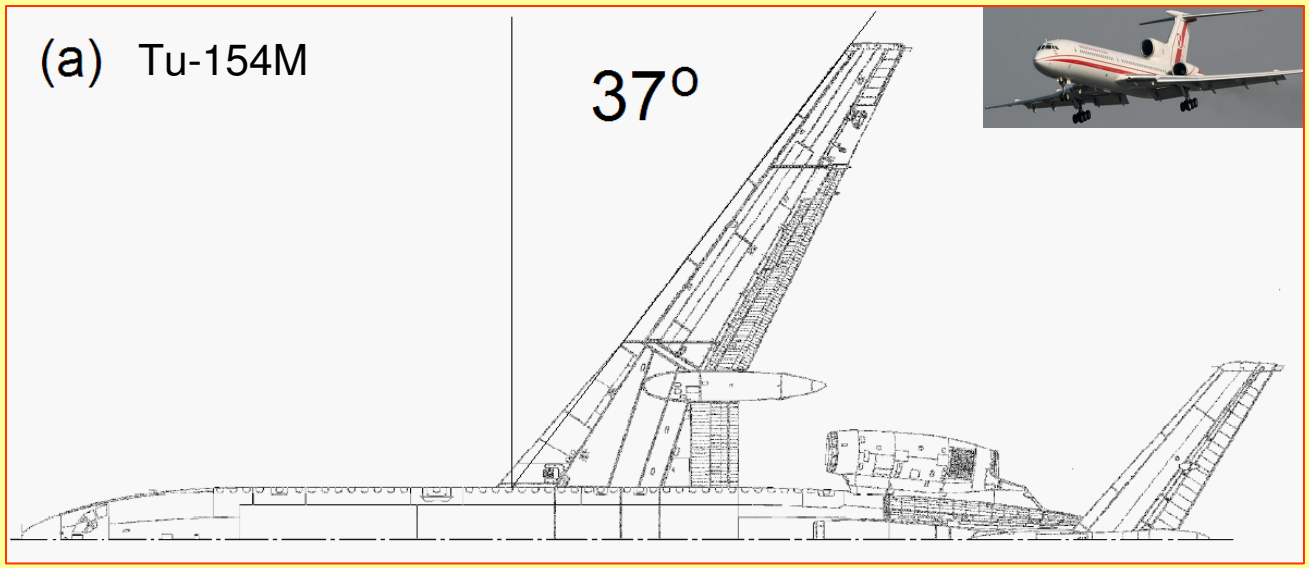
Comparison of wing span: (a) **Tu-154M**; (b) **DC-7**; (c) **LC-1649**



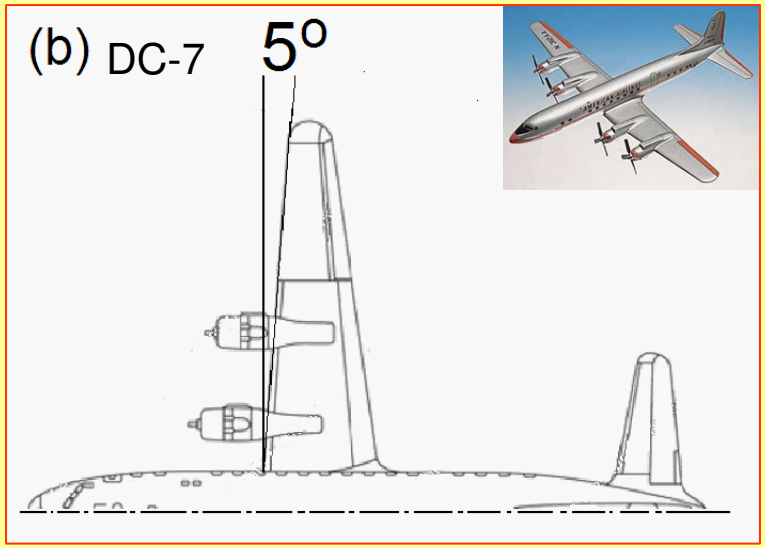
Sweep Angle of Wings

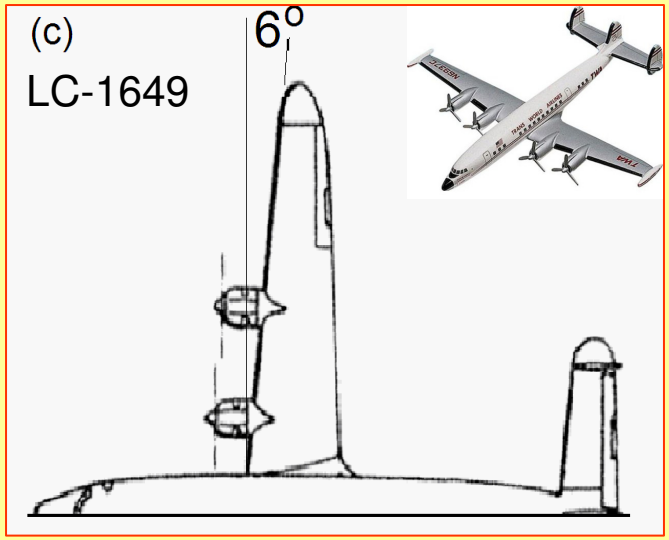


Leading edge sweep of wings of (a) **Tu-154M**, (b) **DC-7** and (c) **LC-1649** aircraft.

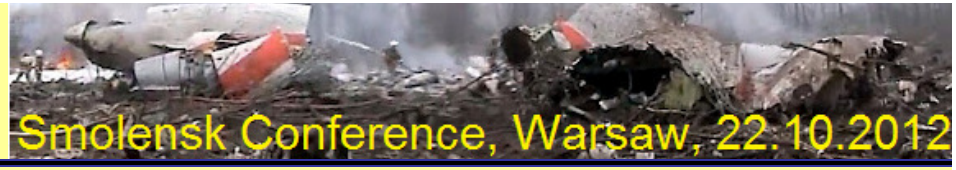


The **leading edge sweep** is the angle between a constant percentage chord line along the semispan of the wing and the lateral axis perpendicular to the aircraft center line





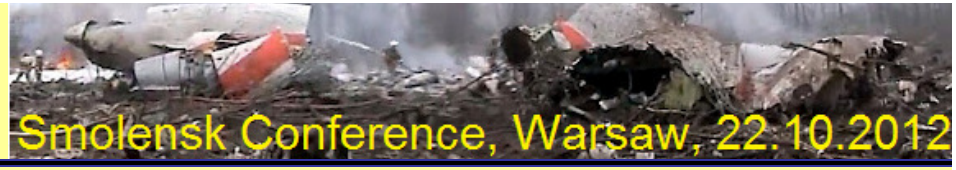
Specifications of Aircraft



Specifications of **Tu-154M**, Douglas **DC-7** and **LC-1649** aircraft

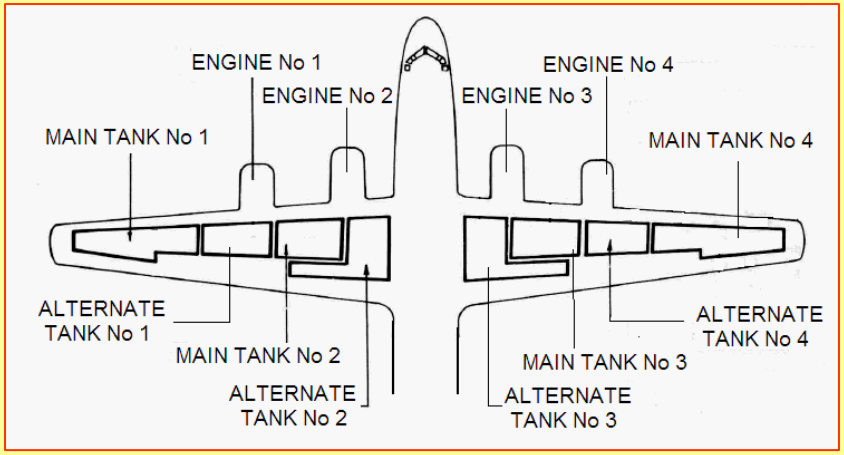
Specifications	Aircraft		
	Tu154M	**DC-7**	**Lockheed LC-1649**
	Dimensions:		
Wing span , m	37.55	34.98	45.72
Length, m	47.90	29.53	35.41
Height, m	11.40	8.75	7.54
Wing area, m^2	201.5	188.3	171.87
	Weights		
Empty weight, kg	55,300	37,785	41,969
Loaded weight, kg	max 100,000	57,200	72,575
	Performance		
Max. speed, km/h	950	650	606 at 5669 m
Cruising speed, km/h		560	466
Service ceiling, m	11,100	6850	7223
Max range, km	5200	9000	9945 + 3628 payload
Range max payload, km	3900	7400	7950 + 8845 payload
Power plant (engines)	3 x D-30KU turbofan rated at 108 kN (24,270 lb) each	4 x R-3350 988TC-DA turbo radial rated at 2420 kW (3250 hp)	4 x R-3350-988TC-18EA-2 turbo rated at 2535 kW (3400 hp) each

LC-1649 Dynamic Crash Test

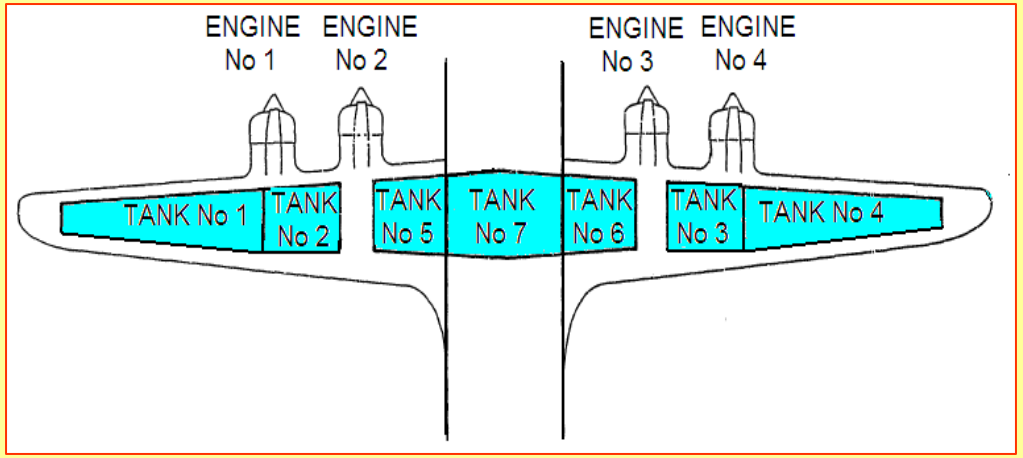


Fuel tank and engine locations

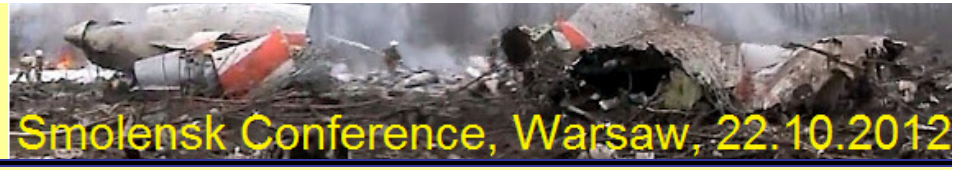
(a) DC-7



(b) LC-1649



Dynamic Crash Tests



The aircraft were released for full-scale dynamic tests under the following arrangements:

- Normal take-off configuration;
- Flaps positioned full-up to reduce lift and drag;
- Upon release, the throttles advanced to pre-determined take-off position (for DC-7 3050 bhp (2.275 MW) per engine);
- Smooth and continuous acceleration of the aircraft during the 1292 m run until the impact with the propeller and landing gear barriers;
- Velocity of 257.4 km/h (139 knots) for DC-7 and 207.4 km/h (112 knots) for LC-1649.

The tests were conducted by the FAA at Deer Valley Airport north of Phoenix, AZ, USA

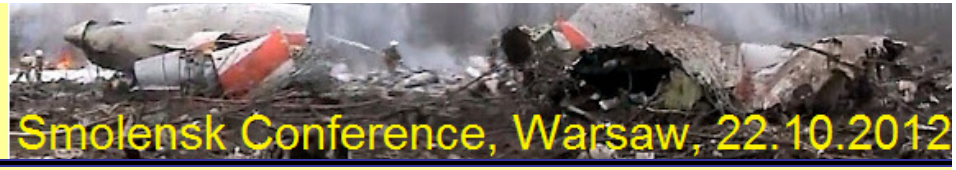
Photo on left shows the DC-7 wheels clipped off and one wing struck by a telephone pole. Photo on the right shows the DC-7 begins to explode into flames apparently unplanned.

http://www.arizonawrecks.com/images/460_DC-7a.jpg

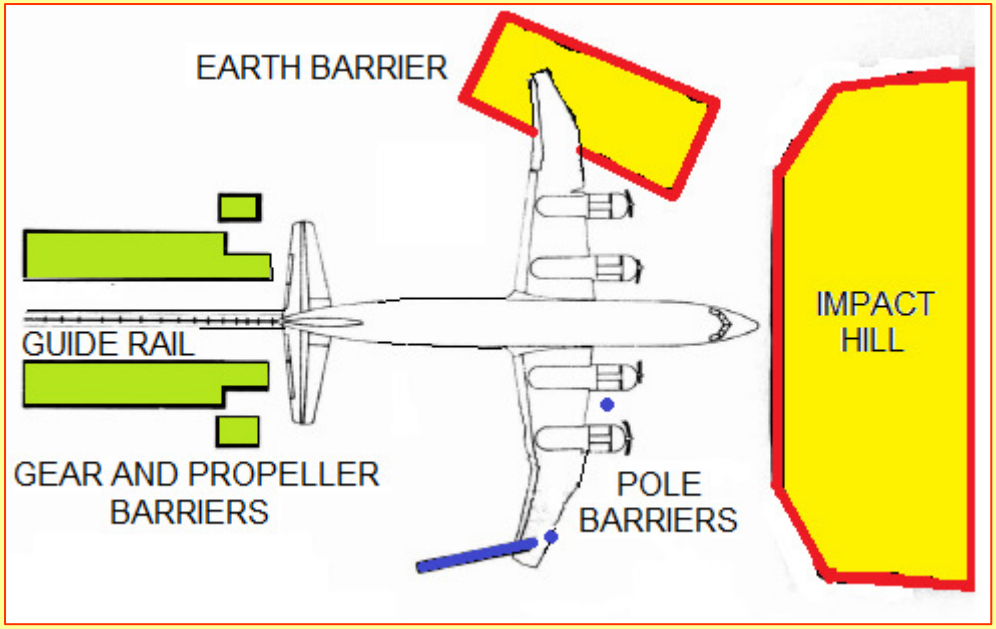
LC-1649 destroyed in the test at Deer Valley. Photo taken by C. Baird.

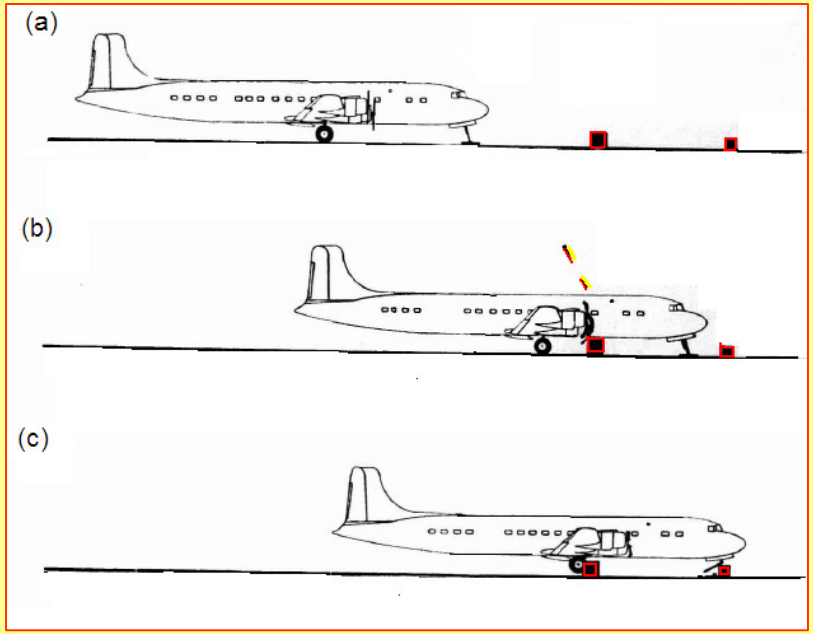
http://www.arizonawrecks.com/images/460_Constellation_N7307C_FAA_crash_web_pic.jpg

DC-7 Dynamic Crash Test



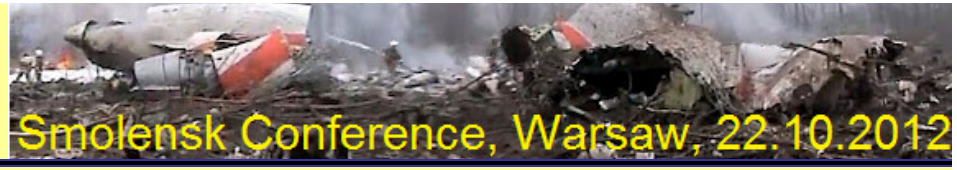
Gear and propeller impact sequence





1. The first barrier was the landing gear barrier.
2. All four propellers were broken as a result of hitting the propeller barriers. All four engine mounts failed.
3. The gear barrier torn out the right main landing gear
4. The outer pole cut off the right wing approximately 3.66 m (12 feet) from the tip.
5. The aircraft hit the second inner pole approximately 0.15 s after the first pole impact. The inner pole struck the right wing between engines No 3 and No 4. The wing leading edge structure back to the forward spar was crushed. Then, the inner pole broke.

Famous “Armored” Birch Tree



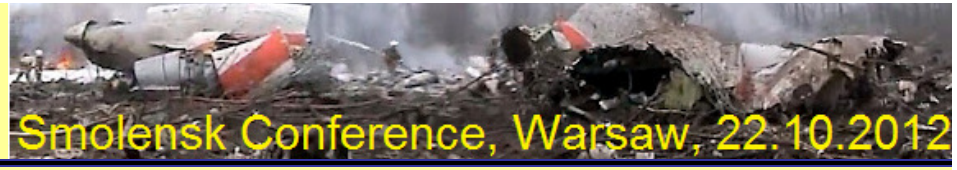
Which photograph is **authentic** ?

Famous “Armored” Birch Tree

Recent photographs. The most important portion has been cut off.

Source: http://imgsrc.ru/para-moto1/30127119.html

Famous “Armored” Birch Tree

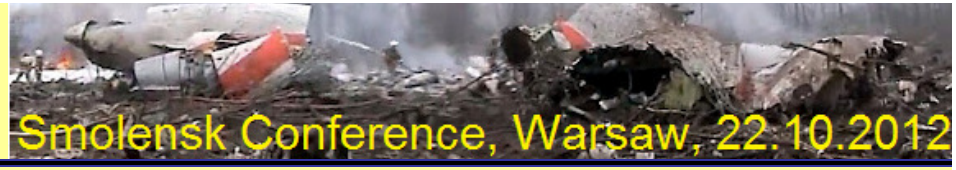


Recent photographs. Dr Bodin’s lot with “armored” birch tree

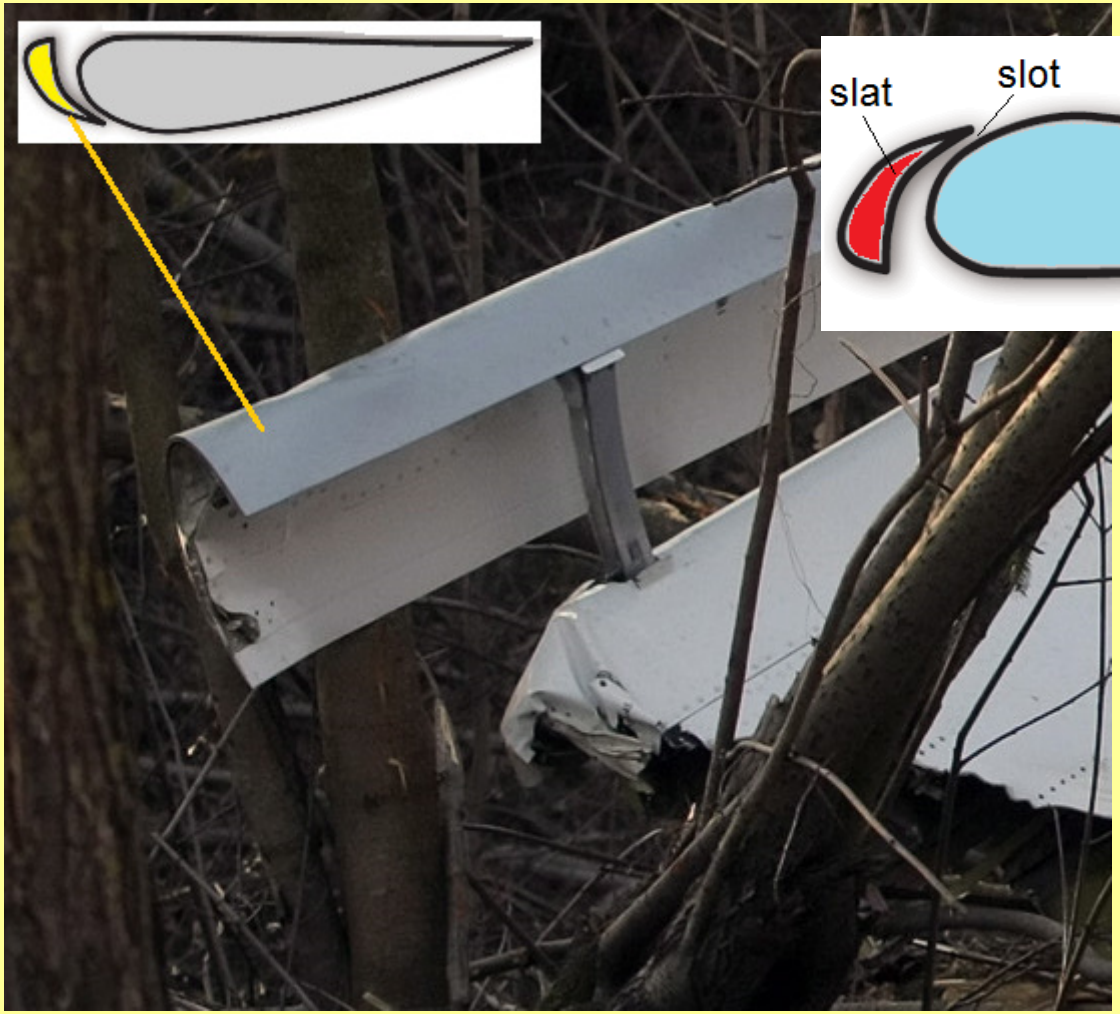
Source: www.google.com

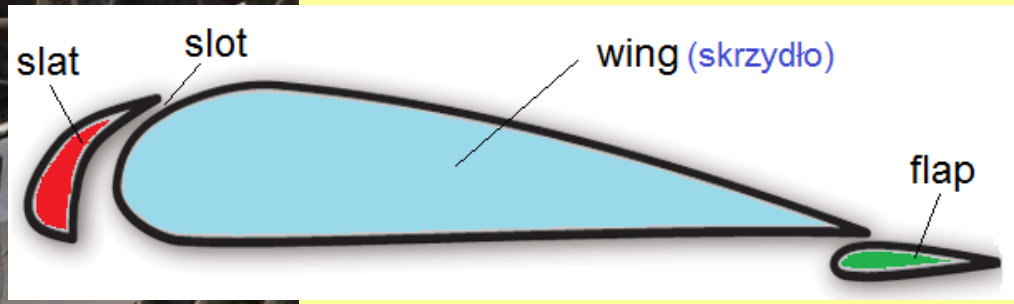
Source: http://imgsrc.ru/para-moto1/30127119.html

Tip of left wing of Tu-154M No 101



The wing has been cut off while the front edge **slat is intact**

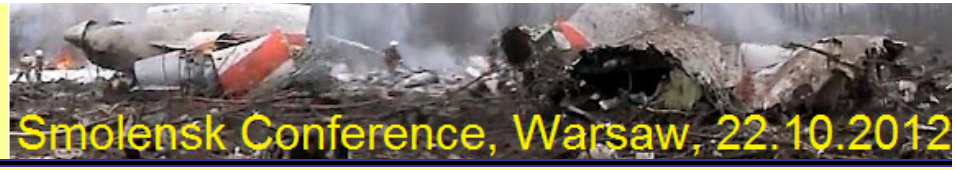




How is it possible ?

http://vfl.ru/fotos/aa582e8c473661.html

Conclusions



(a) The **Tu-154M** is much longer (**47.9 m** versus **29.53 m** and **35.41 m**) and heavier (empty weight **55.3 t** versus **37.785 t** and **41.969 t**) aircraft than the **DC-7** and **LC-1649**.
(b) The construction of the **Tu-154M**, **DC-7** and **LC-1649** aircraft and their wings is very different, e.g., leading edge sweep. The turbofan engines of the **Tu-154M** are mounted in the rear of the fuselage. The piston engines of the **DC-7** and **LC-1649** are buried in wings.
(c) The kinetic energy prior to impact of the **Tu-154M** was **221.1 MJ** versus **125.3 MJ** for **DC-7** and **120.1** for **LC-1649**.
(d) It is easier to cut a pole/tree barrier by a wing with large sweep angle (**Tu-154M**) than by a wing perpendicular to the center line of the fuselage **(DC-7**, **LC-1649**).
(e) The physical parameters of the "live" birch tree are different than those of telephone poles made of processed timber (yellow southern pine).
(f) The height of impact point measured from the ground level is different for each case, i.e., approx **5.1 m** for the **Tu-154M**, approx **3.2 m** for the **DC-7** and approx **2 m** for the **LC-1649**.
(g) The birch tree grew probably in swampy ground, while the telephone poles were buried approximetaly **1.22 m** in the ground. It is unknown if a concreate has been used.
(h) Research performed at the University of Akron and University of Maryland, photographs of the birch taken immediately after crash, lack of damage to the slat and lack of detailed investigation of the birch tree and wing immediately after crash testify that there was rather no collision of the **Tu-154M** Nr 101 with a birch tree.

Therefore, the separation of the tip of wings in full-scale dynamic tests using the **DC-7** and **LC-1649** aircraft can not be a proof that the tip of the wing of the **Tu-154M** was cut off as a result of collision with a birch tree trunk.

Questions & Answers