

TECHNICAL REPORT

Accident occurred on September 13th, 1982,
to McDonnell Douglas DC-10-30-CF aircraft, reg. n. EC-DEG,
at Malaga Airport.

WARNING

This Report is a technical document showing the point of view of the Civil Aviation Accident Investigation Commission relating to the circumstances of the accident subject of the investigation, its cause and consequences.

In accordance to the provisions of Annex 13 to the Convention on International Civil Aviation, and Article 13 of the Decree dated March 28th, 1974, the investigation has an exclusive technical character, not being conducted to declare or limit rights, nor personal or pecuniary liability. The investigation was conducted without using necessarily proof procedures, and with the only purpose of preventing future accidents. The results of the investigation do not preclude nor prejudice those of a sanctioning proceeding which might be initiated in relation to the accident, and according to the Air Navigation Law.

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INDEX OF ABBREVIATIONS

ATC	Air Traffic Control
BX	SPANTAX
C	Degrees centigrade
cms	Centimeters
cm ²	Square centimeters
CVR	Cockpit voice recorder
DFDR	Digital flight data recorder
Dist.	Distance
EM	Emission
IAS	Indicated air speed
IB	IBERIA
ILS	Instrument Landing System
INTA	National Institute for Aerospace Technology
Km.	Kilometers
Kts.	Knots
3L	3 left
lb	pounds
lev	not serious
m	meters
MHZ	Megahertz
m.m.	millimeters
Mov	Movement
MPH	Miles per hour

MTOW	Maximum take-off weight
N_1	Revolutions of low pressure compressor
NTSB	National Transportation Safety Board
PN	Part number
4R	4 right
sec	Seconds
SN-S/N	Serial number
T.O.	Technical order
TWR	Tower
V_1	Speed at which the pilot is supposed to notice sudden and total loss of thrust in the critical engine.
V_2	Speed for climbing after reaching a 35 feet height over the take-off surface, during a take-off with an inactive engine.
V_R	Speed at which the pilot begins aircraft rotation maneuver, in order to raise the nose gear.

Carrier: SPANTAX

Aircraft, type & model: McDonnell Douglas DC-10-30-CF

Nationality: Spanish

Site of accident: Malaga Airport
36° 39' 48" N
04° 29' 02" W

Time & date: September 13th, 1982
at 1000 hours.

Note: Except when determined otherwise, all times in this report are G.M.T..

SYNOPSIS

On September 13th, 1982, at approximately 1000 hours, SPANTAX's aircraft EC-DEG, on flight 995, overshot runway 14 at Malaga Airport, as a result of a rejected take-off. Take-off acceleration was normal, failure was not detected on engines, systems or structures. The crew registered a strong vibration at or close to V_1 . The Captain felt how this vibration was highly increased as he began rotation, consequently rejecting the take-off at a speed between V_R and V_2 . Physical evidence shows how detachment of the tread of a tire of the nose gear, retreaded, began before the aircraft had reached V_1 .

The reject of take-off began when there were another 1,295 meters (4,250 feet) of runway left. The aircraft crossed the runway end at a speed slightly over 110 knots, colliding with an ILS concrete building, breaking the metal fencing of the airport, crossing a highway, causing damage to three vehicles on the same, colliding then with a farming construction. Engine number three was detached after impact with the ILS building. Approximately three quarters of the right wing as well as the right horizontal stabiliser were detached as a result of the impact with the aforementioned farming construction. The fuselage also ran over the construction with which the right wing collided. The aircraft stopped 450 meters (1,475 feet) away from the end of runway 14, and approximately 40 meters (130 feet) off to the left from the centerline. Neither the passenger department nor the cockpit showed damage that could impede survival when the aircraft stopped. Fuel was spilled off the right wing, from the time it collided with the farming construction, and the fire began in the rear of the fuselage. The fire destroyed the aircraft completely. There were 381 passengers and 13 crew members on board. 333 passengers and 10 crew members survived, and as a result of the fire subsequent to the impact, 47 passengers and three assistant crew members died.

1.- FACTUAL INFORMATION.

1.1 History of the flight.

SPANTAX's aircraft Douglas DC-10-30-CF, register EC-DEG, had scheduled a charter flight, number 995, from Madrid (Spain), to J.F. Kennedy Airport (U.S.A.), performing an intermediate stop at Malaga.

That same day the aircraft operated the flight IB-4439, Palma de Mallorca-Madrid, beginning at 0401 hours, with 121 passengers, 13 crew members and four employees from the airline, landing at Madrid-Barajas Airport in order to operate flight BX-995 at 07H36, with 129 passengers, a baby, and the said 13 crew members, arriving at Malaga Airport at 0820 hours, where 251 passengers were embarked. At 0958:50 hours, Control at Malaga cleared BX-995 for take-off. The crew performed a static take-off and acceleration was normal according to the instruments' displays. The captain decided to reject the take-off due to the strong vibrations in the aircraft, not knowing which was their cause.

1.2 Injuries to persons.

I Injuries	I Crew	I Passengers	I Others	I
I Fatal	I 3	I 47	I 0	I
I Serious	I 0	I 40	I 1	I *
I Minor/none	I 10	I 294	I	I

* Driver of one of the vehicles with which the aircraft collided when crossing the highway.

1.3 Damage to aircraft.

The aircraft was totally destroyed by the impact and later fire.

1.4 Other damage.

After leaving the runway, the aircraft collided with the threshold and approach lights, with the ILS (Instrument Landing System) concrete building, with a small wall 60 centimeters high which held the Airport metal fencing, with three vehicles on the highway (two private cars and a delivery station wagon), with the highway center metal division, its kerbs and hard shoulders, drainage, with the concrete structure of a farming construction and the cement protection of a water pump. Damage was also caused to one of the facades of a small building, and to a local road. A publicity panel and its structure were also destroyed.

1.5 Personnel information.

1.5.1 Captain:	Male
Age:	55 years
Licence:	Airline Transport Pilot n. 676
Date of issue:	15/12/66
Licence validity:	10/11/82
Last medical examination:	19/4/82 (using corrective lenses)
DC-10 Rating:	3/11/78

Flight experience:

Total flight time: 16,129 hours

Total time in type: 2,119 hours

Total preceding six
months: 416 hours

Total preceding 90
days: 207.50 hours

Total preceding 30
days: 78.33 hours

Rest period before
flight: Over 24 hours.

1.5.2 Co-pilot: Male

Age: 33 years

Licence: 1st. Class Commercial Pilot n.
228

Date of issue: 23/10/73

Licence: Valid until 6/10/82

Last medical
examination: 15/3/82

DC-10 Rating: 14/12/78

Flight Experience:

Total flight time: 6,840 hours

Total time in type: 2,165 hours

Total preceding six
months: 326 hours

Total preceding 90
days: 173.11 hours

Total preceding 30
days: 57.21 hours

Rest period
before flight: Over 24 hours

1.5.3 Flight Engineer: Male

Age: 53 years

Licence: n. 233

Date of issue: 25/3/63

Licence validity: 15/8/83

Last medical examination: 15/7/82

DC-10 Rating: 14/12/78

Flight experience:

Total flight time: 19,427 hours

Total time in type: 2,116 hours

Total preceding six months: 637 hours

Total preceding 90 days: 215.21 hours

Total preceding 30 days: 70.44 hours

Rest period before flight: Over 24 hours

1.5.4 Assistant crew.

All assistant crew members held the appropriate licences, having performed the training courses.

1.6 Aircraft information.

1.6.1 Type: DC-10-30-CF

Manufacturer: McDonnell Douglas

Date of manufacture: 1977

Serial number: 46962
 Registration: EC-DEG
 Owner: SPANTAX, S.A.

Airworthiness

certificate: 22/1/79 n.1982

Date of last renewal: 18/5/82

Date of expiration: 18/5/83

Total aircraft time: 15,364 hours

Total cycles: 4008

	HOURS	DAYS
Total since Check A:	31	4
Total since Check B:	734	75
Total since Check C:	2,514	297
Total since Overhaul:	15,364	

1.6.2 Engines: General Electric CF6-50C1

Position	Time since Overhaul		Date	Total time hours
	Serial Number	Hours/Cycles		
1	455-247	1627:37/538	17/3/82	13.884:53
2	517-228	622:36/235	6/7/82	12.175:18
3	455-890	3531:18/1088	12/7/81	4.195:25

1.6.3 Weight and center of gravity:

Maximum take-off weight: 558.620 lbs.

Actual take-off weight: 527.657 lbs.

Center of gravity at the
 time of the accident

(within limits): 17.6 % MAC

1.6.4 Take-off data determined by the crew:

Flaps: 8°

Slats: Extended to take-off position
 Stabilizer control: 5.5°
 N1 engine maximum: 113.8
 V_1 162 Kts. IAS
 V_R 169 Kts. IAS
 V_2 182 Kts. IAS

These data were within the limits fixed by the aircraft's flight manual.

1.6.5 Nose gear tires.

1.6.5.1 General Data.

The tires installed on the nose wheels were:

Position	S/N	Retreads	Landing after last retread
1	60970270	4	42
2	713NJ0100	3	14

All the remains of the tread recovered on the runway belonged to the tire placed in position 2.

The markings caused by the nose gear do not evidence burst of any of the two wheels, at least before colliding with the ILS building.

Since their date of installation, the tires did not have to be replaced because

of low pressure. There is no evidence that the wheels were subject to overload.

1.6.5.2 Tire S/N 713NJ0100 history.

Date		Position	Total	Retread
Installation	Removal		landings	
21/3/80	5/5/80	01	84	New
6/8/80	31/8/80	02	60	1R
25/5/82	26/6/82	02	106	2R
9/9/82		02	14	3R

1.7 Meteorological information.

The following information was furnished by Malaga Airport:

Wind:	140 ⁰ /15 Kts.
Visibility:	10 Km.
Temperature:	25 ⁰ C
Dew point:	19 ⁰ C
QNH:	1020.2 mbs.

1.8 Navigation Aids.

Do not affect.

1.9 Communications

TWR-Tower.

Service:	TWR
Call sign:	Malaga
EM:	A3E
Transmits:	118,15 MHz 121,50 MHz Emergency 121,70 MHz Taxi
Hours:	H24.

APP-Approach.

Service:	APCH/SRE/SSR
Call sign:	Malaga APCH
EM:	A3E
Transmits:	119,30 MHz 118,45 MHz
Hours:	H24.

These equipments receive and transmit in the same frequency. They include recorders hence the communications were registered.

1.10 Aerodrome information.

Runway 14 at Malaga Airport has a magnetic heading of 138 degrees, its surface is made of asphalt on concrete, it has no grooves, its length is 3,200 meters and is 45 meter wide. It includes two 75 meter long stopways and a longitudi-

nal slope of 0,2%. The airport's elevation is 16 meters.

The ILS (Instrument Landing System) Localizer building of runway 14 was approximately 290 meters away from the threshold of runway 21, and about 22 meters to the left of the runway's center line extension. It was made out of concrete.

1.11 Flight recorders.

The aircraft included CVR (Cockpit Voice Recorder), and DFDR (Digital Flight Data Recorder), which were recovered the morning next to the accident.

By decision of the Spanish Authorities and in the custody of a representative, together with members of the NTSB (National Transportation Safety Board) of the USA, both recorders were taken to Sundstrand laboratories, the manufacturer, for opening and extraction of data.

1.11.1 CVR

The aircraft included a Sundstrand CVR, model V-557, PN 103600 SN 1232.

Once recovered, it could be seen that its shielding, the tape recorder equipment, etc., formed one solid block due to the persistent and prolonged action of fire.

They were opened at Sundstrand laboratories, verifying that the magnetic tape had been destroyed because of the intense heat.

No information could be obtained from this Recorder.

1.11.2 DFDR

The DFDR on board the aircraft was a Sundstrand, model 573A, PN 981-6009-011 SN 3008.

It was opened at Sundstrand laboratories. The vic alloy magnetic tape showed some residuum, mainly where it appeared out of the reels, due to detachment and adherence of particles of the recording equipment itself, which was caused by the intense heat suffered by the Recorder.

Reading was only possible after a lengthy and careful cleaning process.

A first reading was carried out at Sundstrand laboratories, data were obtained and master copies were made. These were then sent for processing to NTSB laboratories, in Washington.

A study of DFDR data shows that stopped its recording when engine number 3 collided with the ILS building, probably deenergizing the generator bar of the said engine which feeds the DFDR, thus stopping current flow to this equipment.

The last reading showed a magnetic course of 126,56 degrees and a speed of 95,08 knots IAS.

1.12 Wreckage and impact information.

The aircraft abandoned the runway through threshold 32, to the left of the center line, breaking some of the threshold lights. The aircraft, still in the airport, collided firstly with a ILS concrete building sited at a distance of 290 meters from the threshold approximately 22 meters from the centerline, beside the airport fencing.

The building and the equipment it contained were totally destroyed by the impact of the aircraft's number three engine.

Engine n. 3 detached as a result of this collision, remaining on the runway sited next to the fencing and about 20 meters away from the ILS building.

The aircraft broke the airport's metal fencing, and when crossing the highway caused damage to three vehicles which were driving on the same.

After crossing the highway, it collided with a farming concrete construction which protected a water pump, where the greater part of the wing, gear, and tail wing remained, all of them belonging to the right side of the aircraft. Fuel was spilled from this zone to the place where the aircraft finally stopped.

After colliding with the aforementioned construction, the aircraft ran over a small talus 1 meter high, the left wing's tip grazed a farming construction, causing damage to its facade thus losing the left wing's tip. The aircraft stopped on a second talus of a similar height, though the part of the cabin placed before the leading edge surpassed it.

It may be considered that the fire began instantly, subsequently surrounding the zone of wreckage and affecting the whole of the aircraft except the left wing.

1.13 Medical and pathological information.

The aircraft's successive impacts, from the collision with the ILS building, sited on the runway extension, until it came to a final stop, did not generate structures deformation which might have caused traumatic injuries to the people on board.

The only traumatic injury was suffered by the driver of a delivery station wagon, on account of the impact of the aircraft when crossing the highway.

After crossing the highway the aircraft collided with a water pump concrete protection, starting a fire before the aircraft had finally stopped.

Eight people died as a consequence of the direct fire that entered into the aircraft, probably through the breakage of the top part of the passenger department in next to door 4R, due to deformation caused by an impact.

After examination of the other victims, it is established that they suffered an incapacitation due to carbon monoxide intoxication, dying later by action of fire.

Most of the injuries to the survivors occurred as a consequence of fire and gasses from the same.

Slight traumatisms and injuries occurred during the process of evacuation of the aircraft, most of them as a consequence of the way in which the slides remained, due to the position of the aircraft.

1.14 Fire.

The aircraft had fuel on board for the transatlantic flight it was going to perform. The fire might have started as a consequence of the impact of engine number 3 with the ILS building, or by the impact with the water pump protection, with which the aircraft collided after crossing the highway, breaking the left wing and spilling fuel from this zone to the rear end of the fuselage of the aircraft between the right wing and engine number 2. There is no evidence of fuel spilling from the tanks before the impact with the water pump protection.

The firemen were advised immediately by the tower, who was following the aircraft's take-off visually. Mobilization of personnel on duty as well as of fire fighting vehicles was complete.

The estimated time of arrival to the site of the accident and subsequent fire fighting action is approximately of five minutes. Pictures taken by a passenger show fire fighting vehicles at work while there were still passengers leaving the aircraft through door 3L. The firemen cooperated in the rescue of approximately 15 passengers which were leaving the aircraft through the said door, removing five injured passengers, some of them unconscious, which were under the left wing exposed to smoke and fire, due to the proximity to the same.

The fire fighting team was composed of a foreman and twelve firemen, using six vehicles.

Other units from ICONA and the municipality, as well as the remaining personnel of the Airport's Fire Fighting Service, not on duty, arrived when they knew the accident.

1.15 Survival.

Survival of people on board was possible in this accident.

From the time the aircraft left the runway to the moment it stopped, traumatic injuries were not suffered by the passengers.

The alarm was immediately given by the controller following visually the aircraft's take-off and by the personnel from Malaga Air Base, who saw how the aircraft left the runway.

The Airport's aid vehicles found the access to the site of the accident barred by remains from the ILS building and by the rubblework closing which prevented them from leaving the Airport area. Subsequently they faced greater problems on account of the traffic jam occurring in the highway going southwards. The vehicles from the Base arrived sooner since they followed the direction opposite to Malaga-Torremolinos, in the highway, on their way to the site of the accident.

The order of evacuation could not be given due to the fact that the airplane had lost electric current and because it did not have an evacuation warning system, being not compulsory at present regulation. Nevertheless, and in the presence of the accident, the assistant crew, immediately after the airplane stopped, opened the doors and ordered the passengers to leave the aircraft. Loud speakers were not used due to the difficulty found when trying to access the place where they were installed.

Doors 1L, 1R and 2L were opened and used immediately.

Although the stewardess in charge of opening door 3L saw there was fire on the left side, she decided to open it since the fire was bigger on the right side.

The stewardess in charge of opening door 2R, seeing the fire outside, decided not to open the door and conducted the passengers to door 2L. Later a passenger opened it and once 3 or 4 passengers used it to exit the airplane, the escape slide was destroyed by the fire, and the fire began to invade the cabin.

The stewardess in charge of opening door 3R, due to the fire outside, decided not to open the door and believing that the fire was on the right side, conducted the passengers to door 3L.

According to statements of passengers, it is known that the three stewardesses at the rear part of the airplane tried to open doors 4L and 4R, but they could not do it probably due to structural deformation caused by impacts or fire.

The 91 passengers in the first cabin left the airplane through doors 1L, 1R and 2L.

The 122 passengers in the second cabin left the airplane through doors 2L, 3L and few of them used door 2R.

The third cabin was occupied by 167 passengers. The 117 passengers that left the airplane they did it mainly through door 3L, which was affected by the fire during most of the evacuation and whose ramp soon became unusable.

The 47 passengers and 3 assistant crew members who died, occupied the third cabin.

Several statements reveal that the tail was invaded by fire and very dense smoke, probably due to a breakage on the top part of the passenger department, near door 4R. This was probably the reason for the fast incapacitation of the three stewardesses that were beside doors 4L and 4R, reason by which they could not reconduct the evacuation in their zone nor notify the rest of the crew about what was happening.

The evacuation in cabins one and two was slow because the passengers, that boarded the aircraft with a great deal of hand luggage, remained collecting their belongings before leaving the aircraft.

In the third cabin, apart from the hand luggage problem, there was a jam due to the great number of passengers using mainly the left corridor in order to reach door 3L, through which evacuation was difficult on account of the ramp's destruction by fire.

Fire and smoke invasion was the cause for the incapacitation of the victims which were trapped inside this cabin.

The lack of visibility due to smoke and fire, and the screen separating the cabins, prevented from having an overall view of the airplane, and in fact three different evacuations took place, one in each cabin.

The evacuation of the injured was carried out in private and sanitary transport vehicles.

A Spanish Air Force ambulance, with a doctor and a Sanitary Technical Assistant arrived in less than five minutes. Five minutes later four ambulances from the Airport, with two doctors and two Sanitary Technical Assistants arrived. 3 twenty-seat minibuses, a closed van and 3 eight-seat minibuses arrived within 5-15 minutes approximately. Two ambulances, 2 doctors and 2 Sanitary Technical Assistants arrived within 15-30 minutes. Approximately 30 minutes had passed before 50 ambulances arrived, though they were not necessary since the evacuation of the victims from the site of the accident had been completed.

116 cases were taken care of at the first medical assistance post (the Airport's Sick Bay). The majority of the survivors seriously affected were taken to the Hospital Carlos Haya of the Insalud (Malaga).

Evacuation to other hospitals was carried out with no problems due to two factors:

- the road from the site of the accident to the Residency of the Insalud was not congested.
- Once the traffic police had arrived to the scene of the disaster, one lane was reserved for the exclusive use of vehicles assisting to the accident.

1.16 Tests and research.

1.16.1 Investigation of the tread of tire.

The remains of the tread of the airplane's tire recovered on the runway, were sent to the INTA (National Institute for Aerospace Technology) in order to determine, through non-destructive means, the cause of the tread's detachment from its tire.

The tire had been retreaded by PNEV MAEDER AG, from Zurich, for the third time, Certificate n. 21.962 dated August 6, 1982, S/N 713 NJ 01000, and installed on September 9, 1982.

It had performed 14 landings from the date of its third retread.

The manufacturer's sign was molded on the tire: Good-Year, size 4x5 5-16, PR 26, speed 235 MPH.

The tire belonged to a nose gear composed of two wheels. It was placed in position two. The other wheel on the nose gear had been retreaded four times, and was installed on August 31, 1982, and had performed 46 landings.

1.16.1.1 Visual Inspection.

None of the breakage surfaces studied, even those protected by layers of rubber or cord weave, unsticked but not detached, showed to have traces of rubber dust caused by friction between unsticked layers, before the breakage/s which led to loss of pieces of tread occurred.

The tread's wearing can be considered normal, not existing a specific zone presenting a wearing whose characteristics are those of a typical violent sudden braking. Certain zones show slight wearing differences caused by the first contacts in touch-downs.

It should be pointed out that the whole of the tread of tire is not available.

According to the study of the pieces, the retread seems to be type 3 (Full cap) of those defined in T.O. 45-1-3 "Inspection, Maintenance instructions, storage,

and disposition of Aircraft Tires and Inner Tubes" section I page-1-5/1-6.

In order to perform a detailed description of the visual inspection of the pieces of tire received, Figure 1 includes a representation of the layers observed so as to simplify the description of the faults found.

Observation of the pieces leads to the conclusion that the part detached from the carcass, which must belong to the retread, is formed by the following layers:

- a rubber strip about 8-10 mm thick, corresponding to the tread of tire.
- two layers of cord weaving.
- a rubber intermediate strip, about 5 mm thick.
- a third layer of weaving which is only present in piece 4-5 (Photograph n. 2) and in an unnumbered piece (Photograph n. 4). In both cases, the thickness of this layer is of about 5-7 cm.

Taking into account the various faults found, and the layers where they occurred, caused either by unsticking of two adjacent layers (adhesive fault) or by tear of one of them (cohesive fault), the following clas-

sification has been established according to the type of fault, which are pointed out by the indicative number in the referred photographs:

Type 1:

Unsticking between the tread of tire rubber and 1st. layer of the weaving (photographs 1 and 5).

Type 2:

Unsticking between 1st. and 2nd. layers of the weaving (photographs 1 and 6).

Type 3:

Unsticking between 2nd. layer of the weaving and the intermediate rubber strip (photograph 2).

Type 4:

Tear of the intermediate rubber strip. In order for this fault to appear, it seems obvious that the adhesion of the rubber strip to 2nd. and 3rd. layers of the weaving or to the 2nd. layer of the weaving and the carcass, was greater than the resistance to the tear of the rubber (photographs 3 and 4).

Type 5:

Unsticking between 3rd. layer of the weav-

ing and the carcass, leaving the threads of the carcass exposed. In this case, the adhesion of the rubber film of 3rd. layer of the weaving to the carcass was greater than that of the said film to the weaving of 3rd. layer (photographs 3 and 4).

Type 6:

Unsticking between the intermediate rubber strip and the carcass. It is stated that it unstuck from the carcass because the pattern appearing on the rubber is not of the type left by a cord weaving included in the retread, both in the separation between prints and in the shape and irregularities of the same (photographs 3, 4, 6, 12 and 13).

Type 7:

Unsticking between 3rd. layer of the weaving and the carcass, remaining the said 3rd. layer of the weaving covered by its corresponding rubber film. Comparing this fault with number 5, it may be asserted that the union of the film to the weaving is better than that of the film to the carcass.

In this case, in order to classify as unsticking of the carcass, the same criteria used for fault number 6 with relation to the pattern appearing on the rubber film (Photograph num. 3).

Prior to the detailed study of every piece, it must be noted that 3rd. layer of the

weaving was only found in two relatively small pieces. In both cases, it appears as a 5 cm. wide layer, and the direction of the threads does not match with any other layer of weaving (photographs 3 and 4), i.e., this layer 3 does not follow the alternating direction beginning in the other two, which would be the normal thing, as the aforementioned fig. 1-1 from T.O.-45-1-3, shows.

Type 8:

Tearing of the intermediate rubber strip, presenting an alveolar surface, surrounded by a spongy zone. Photograph n. 7 and details in n. 8, 9, and 10. It could be considered as a variant of type 4. This type of breakage is found in a not very large zone, below the central zone of the tread of tire.

1.16.1.2 Breakage due to fragmentation.

Besides the type of faults already described corresponding to a loss of continuity, in a radial direction, between them or with respect to the carcass, of the various layers described in the above paragraphs, the pieces examined show a certain amount of breakages whose plane is oriented in an approximate radial direction, corresponding to fragmentation, in whole or in part of the referred layers, and that generally interest the thickness of the

layers appearing in the zone of this breakages.

1.16.1.3 Results of the visual inspection.

Once all the pieces collected were examined, the numbering appearing in them was maintained as a reference.

Piece n. 1.

It is composed of various pieces, they are put together with adhesive tape for display and study, forming a group of about 50 cm. long and a width covering both sidewalls, up to almost below the corresponding shoulder.

The inscription "Good-Year 40x15 5-16" appears in one of the sidewalls.

There are certain longitudinal breakages, coinciding always with the grooves of the pattern of the tread of tire, and other transversal breakages that cover the rubber of the tread of tire and 1st layer of the weaving, presenting some zones affected by faults belonging to types 1,2, and 6.

Around the center of the group and coinciding with the bottom part of the central zone of the tread of tire, appears a small piece of rubber characteristic of type 8 fault.

Piece n. 2.

Similar in size to piece n. 1. Includes the inscription "Maeder Zurich PR 26".

It includes a piece of the central tread of tire joined to one of the lateral treads (beside the sidewall) through 1st layer of the strength weaving, which is exposed due to absence of the rubber tread of tire between the central and lateral tread of tire (Type 1 fault). It should be pointed out that this piece of tread was part of piece n. 3 (photograph 5). Type 2 fault is seen on all the surface in its inner part.

Piece n. 3.

There were five pieces with this number. One of them was part of piece n. 4 and shall be described accordingly.

Another piece was mentioned in the description of piece n. 2.

A piece of approximately $30 \times 15 \text{ cm}^2$. A part of it shows a type 6 fault. In another small part it is observed a type 4 fault. In certain small zones type 1 and type 2 faults appear. A piece of about $15 \times 10 \text{ cm}^2$ presenting along its surface type 2 fault.

A piece of about 60x20 cm² (photograph n. 6), with a wide zone affected by type 2 fault. A smaller zone corresponds to type 6 fault.

Type 4 fault appears in a small part, and type 1 fault appears in a zone a little bigger.

Shows a cut of 1st layer of the weaving and another cut involves all the layers.

Other piece with long fringes showing to a great extent type 2 fault, a small part presenting type 4 fault and long fringes from layer 1 of the weaving, unstuck from the tread of tire (type 1 fault).

Pieces n. 4-3.

About 80 cm. long and its width corresponds to that of two side walls of the tread and the flank. Type two fault appears on most of its surface. Type one fault appears on a smaller zone. There are large fringes of the first layer of weaving on one of its sides (type 1 fault).

Pieces n. 4-5.

Irregular (photograph n. 3). Different zones appear, affected by type 1, 4, 5, 6, and 7 faults.

Piece n. 5.

About 60 cm. long, its width corresponding to the tread of tire plus one of the sides up to the sidewall.

Type 2 fault appears on most of its surface, and type one fault appears on the rest.

Grooves and breakages of the weaving of the first layer appear in a transversal and longitudinal direction. The main breakage, in a longitudinal direction, covers the weaving and the rubber of the tread of tire through the the pattern's groove.

Other pieces.

There are other smaller unnumbered pieces, some of which are:

- one of approximately 20×20 cm² (photograph n. 4).

A smooth surface, corresponding to type 2 fault, appears on one of its faces.

On the opposite face there are three different zones affected by type 4, 5, and six faults.

- Various pieces which could be placed consecutively due to coincidence of the lines of breakage, resulting in a group of about 70 cm in length, along the central tread of tire (photograph n. 7).

- The most outstanding characteristic of this reconstructed piece is that it shows the intermediate rubber strip exposed, highly worn out in a zone of about 3,5 cm wide and 70 cm long. After careful examination it is observed that the deterioration of the rubber strip is progressive from one end to the other, in such a way that as it advances a series of aligned holes appear, in the direction of the threads of the woof of 2nd. layer of cord weaving, its number growing from one hole at the beginning to 7-8 holes at the end (see photographs 8 and 9 for details D-1 and D-2 of photograph 7). Next to these semispherical holes, there are numerous small holes which have in certain zones a tone darker to that of the rubber itself, as if they had been signed by a too high temperature. This zone appears in general as a thin ripped sponge (Type 8 fault).

1.16.1.4 Quantification of the various types of fault.

Taking into account the difficulties found when measuring as a consequence of the irregularity and variety of shapes of the pieces of the tire and of the zones of the types of fault, as well as the overlaps which appear in some of them, the surfaces of the different types of faults observed were measured, in an inside-outside view.

The results, which figure in cm^2 , figure in Table I.

Table I

Fault Type

Piece number	1	2	3	4	5	6	7	8
1	40	1200	-	-	-	150	-	12
2	250	600	-	24	-	-	-	-
3	30	920	-	15	-	245	-	-
4	60	1100	-	-	-	200	-	-
4-5	10	-	-	104	15	70	125	-
5	110	1100	-	-	-	-	-	-
other	588	560	20	386	100	258	-	150
sum	1088	5480	20	529	115	923	125	162

The figures obtained, translated into percentages of the total surface measured, are rounded as follows:

Fault type	%
1	12,00
2	66,00
3	0,25
4	6,25
5	1,35
6	11,00
7	1,15
8	2,00

1.16.1.5 Magnifying glass inspection.

In order to achieve a deeper inspection of type 8 fault, the corresponding zone has been examined with a magnifying glass. Photograph 10 shows a detail of this inspection with a x3,5 magnification.

The surface of the bigger holes is very smooth; this characteristic may correspond to the marks left by a bubble of gas. Deep in everyone of these holes lies a thread of the wool from 2nd. layer cord weaving. One can also see some zones in the wool which included a greater amount of size resin.

1.16.1.6 Radiographic Inspection.

The spongy zone only appears under the central tread of tire. It was thought convenient to investigate if this type of flaw (spongyness) spread circle-shaped under the central tread of tire.

Piece n. 3 in photograph 6, is the only piece of the central tread of tire that remains joined to the rest of the layers concerned.

A radiograph was made of this zone (photograph n. 11) in order to detect, if any, holes of the type described in the above paragraph. No cavity was found, which

leads to the conclusion that the sponginess is not spread along and below the whole of the central tread of tire, although it cannot be determined the total zone in which this fault appears.

1.16.1.7 Final considerations and conclusions.

1.16.1.7.1 Retread faults.

* The most common fault (66%) among those detected is fault 2, "unsticking between 1st and 2nd layer of the weaving". Basically just an adhesive fault is detected in it, with almost no evidence of cohesive fault, indicating an unusually poor adhesion achieved in the process of retread.

* The second most common fault, as a percentage, is fault 1 (12%), lower by far than the aforementioned fault. A study of this fault shows that adhesion between the tread of tire and the first layer of cord weaving is better than that found in fault 2 since this one includes zones of cohesive breakage.

* The third place as a percentage belongs to type 6 fault (11%), very close to type 1 and with similar characteristics.

* It must be pointed out that the third layer does not cover the whole of the retreaded surface, while the other two layers do seem to cover it. The only two pieces in which the said third layer appears figure in photographs 3 and 4; after observation of the piece in photograph 4 it cannot be asserted that the said 3rd layer of weaving does not cover the whole of the surface, since the prints found on the intermediate rubber strip, beside the 3rd layer of weaving, follow the direction of the weaving and it can be admitted that the said layer was stuck to them. In return, piece 4-5, in photograph 3, shows some prints on this third layer which seem to correspond to the carcass itself and that continue on the intermediate rubber strip (position 4 of figure 1), similar to the ones appearing on the intermediate rubber strip in photograph 12, piece 1, and photograph 13, piece 3, in which this third layer does not exist. Precisely these pieces in photographs 12 and 13, show how the intermediate rubber strip comes to the sidewall, which enables to state that the said intermediate strip was installed in the last retread.

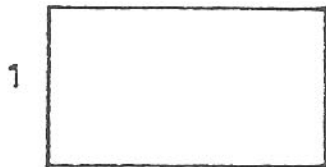
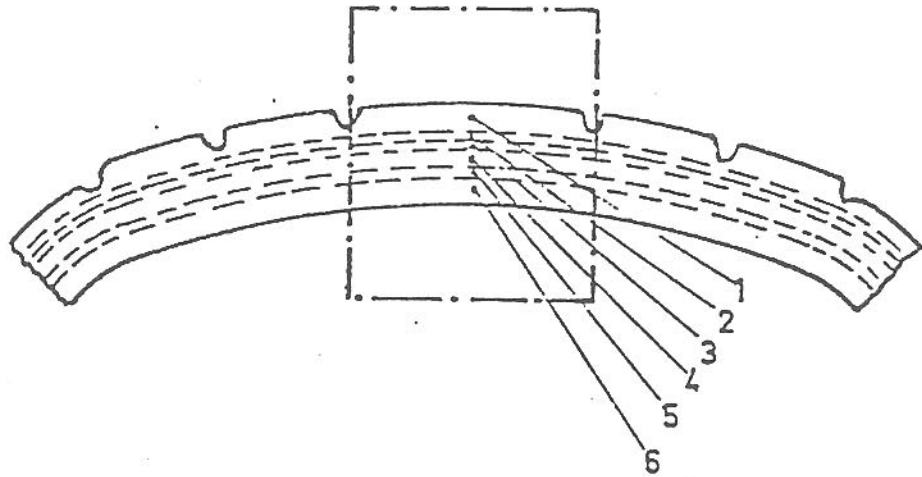
* In relation to type 8 fault, in which holes and sponginess appear, it is worth saying that the holes are aligned precisely

over the threads of the woof of 2nd. layer of weaving. Furthermore there is a different degree of impregnation of the threads of the weaving.

Regarding type 8 fault, due to its characteristics, one may take into account the hypothesis by which the flaw occurred during the retreading process, caused either by a faulty removal of the bubbles or by the presence of gas in the process of vulcanization, or by vaporization of excess of size resin from the cord weaving.

1.16.1.7.2 Detachment of the tread of tire.

* Fragmentation mentioned in paragraph 1.16.1.2 indicates a sequenced detachment of the pieces, some of the same remaining joined to the carcass during a certain time.



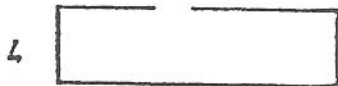
Rubber of tread of tire.



1st. layer of weaving



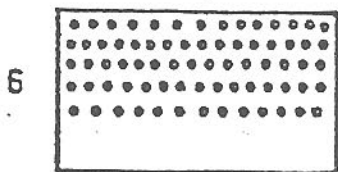
2nd. layer of weaving



Intermediate rubber strip

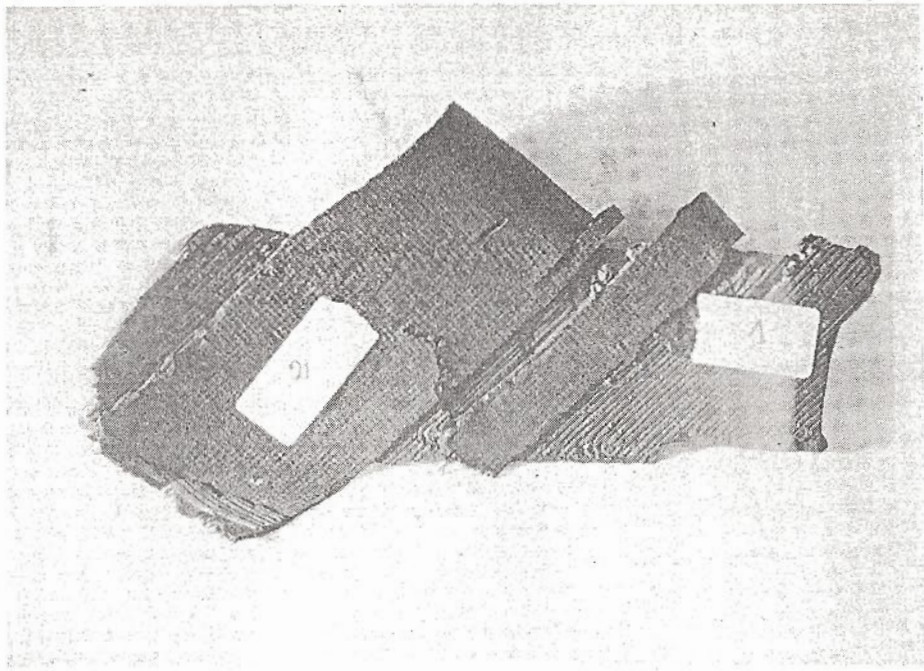


3rd. layer of weaving

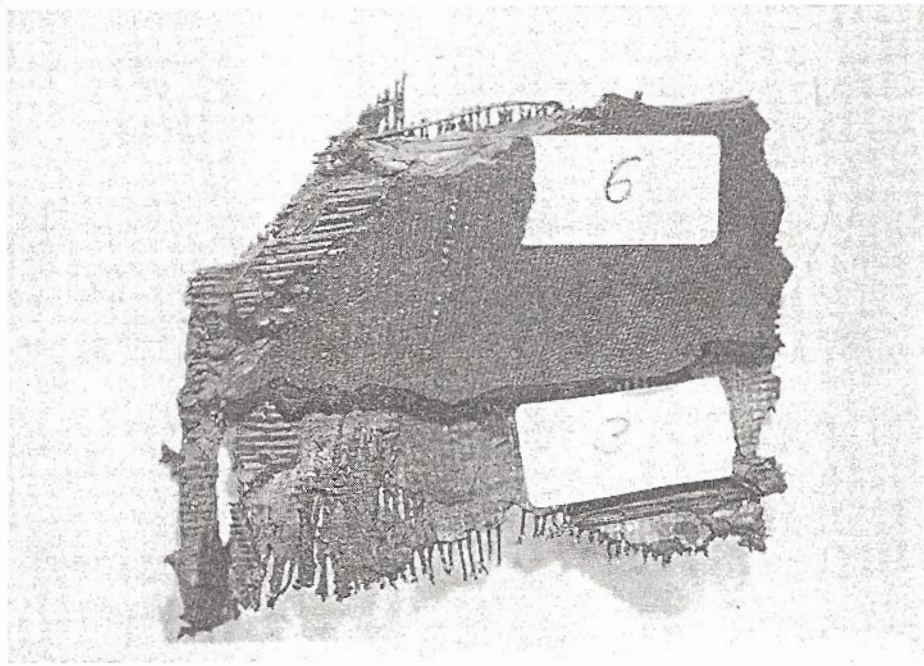


Carcass

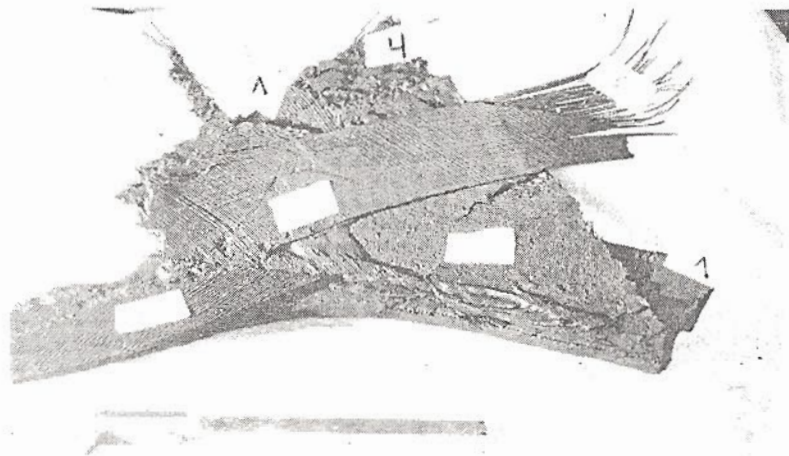
FIG.- 1.



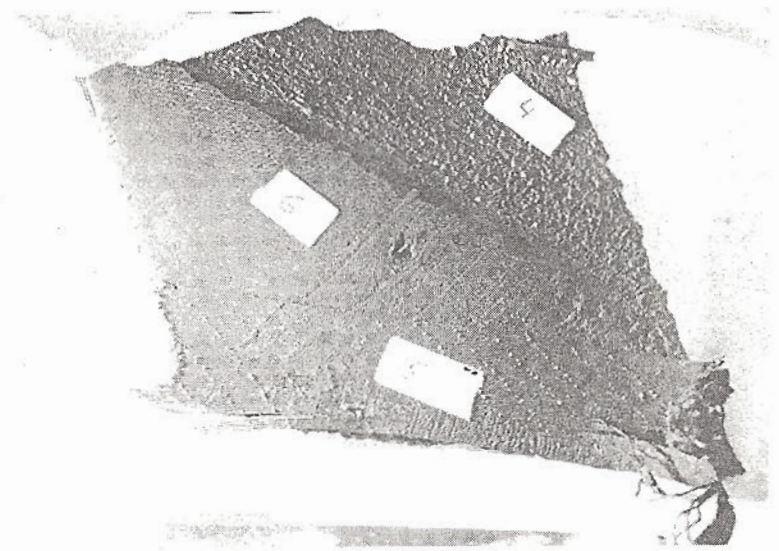
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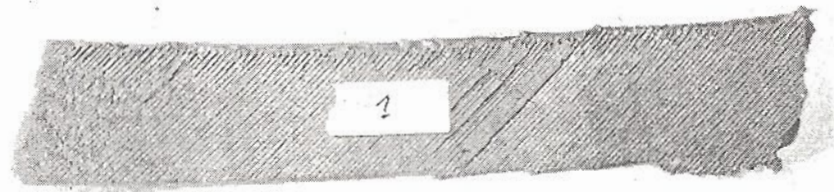
2



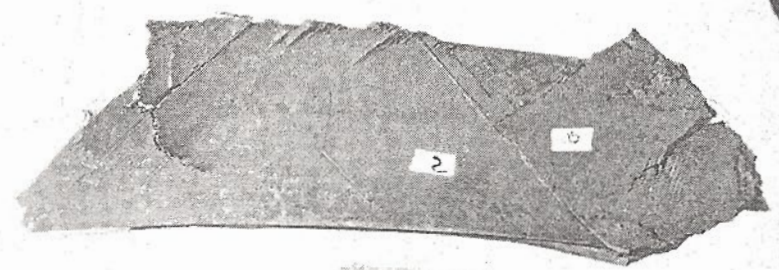
3



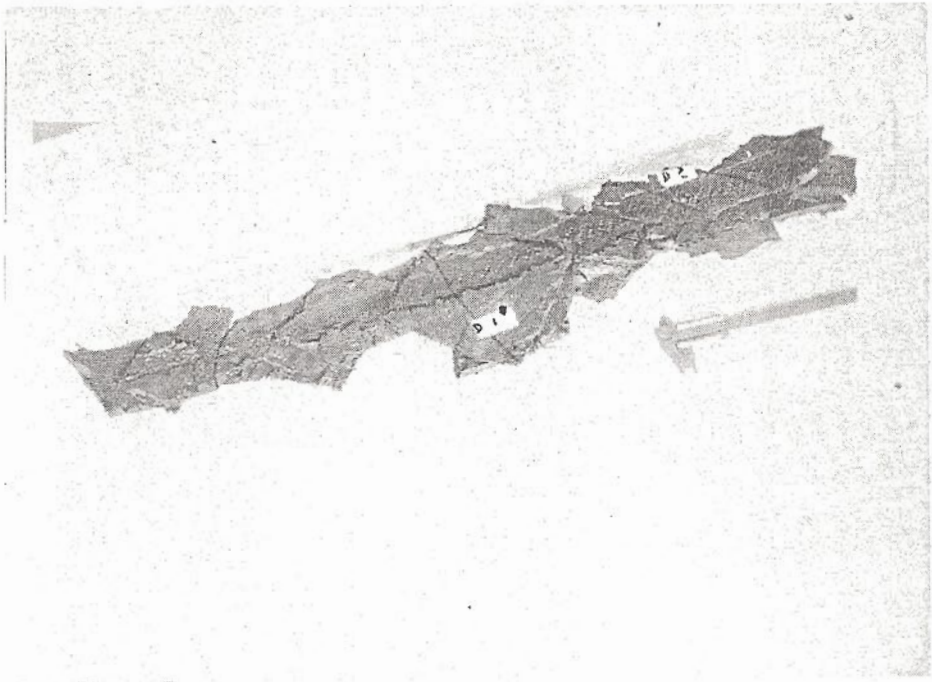
4



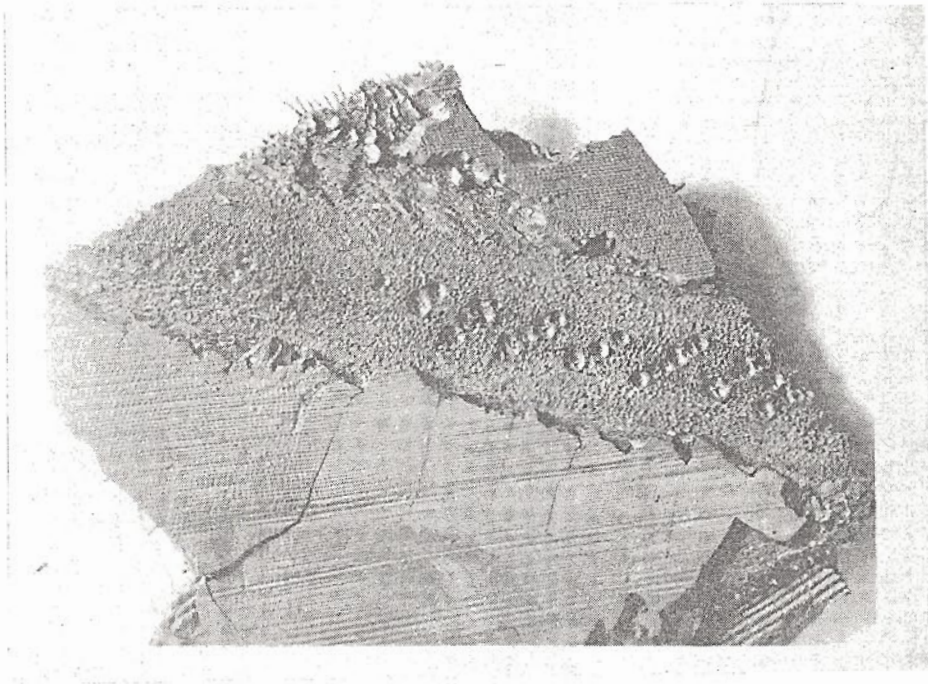
5



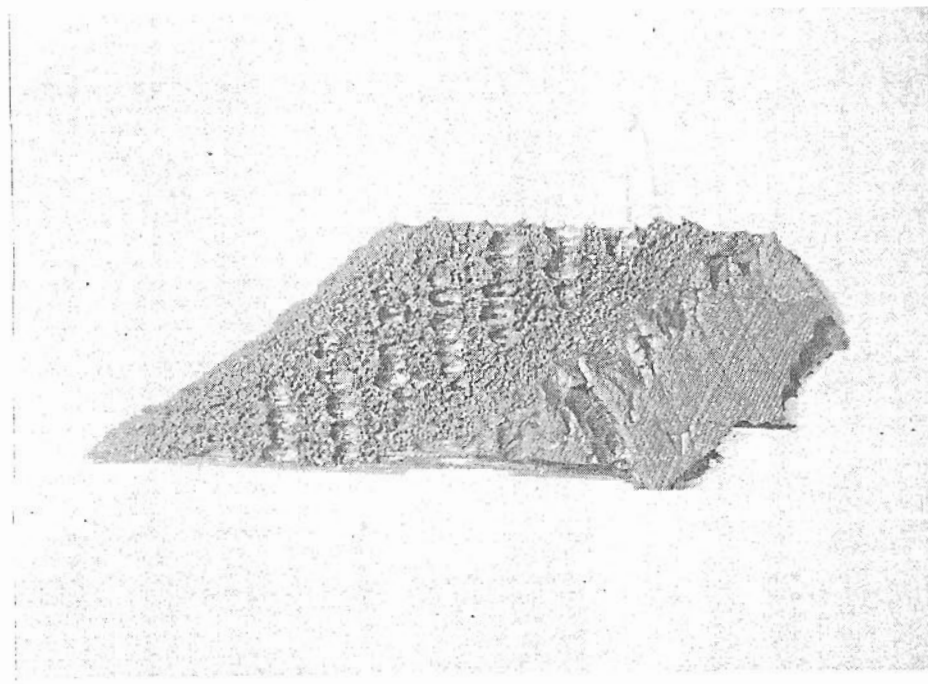
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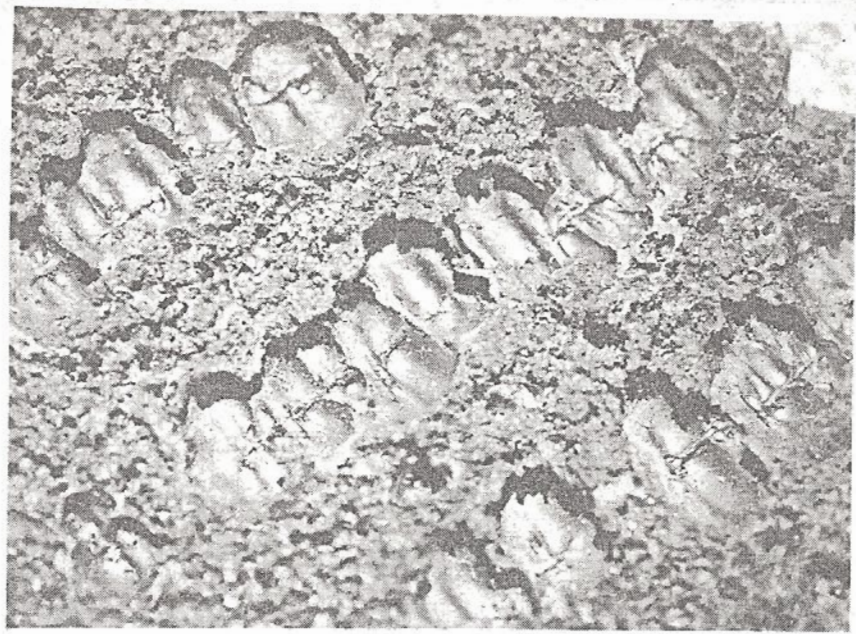
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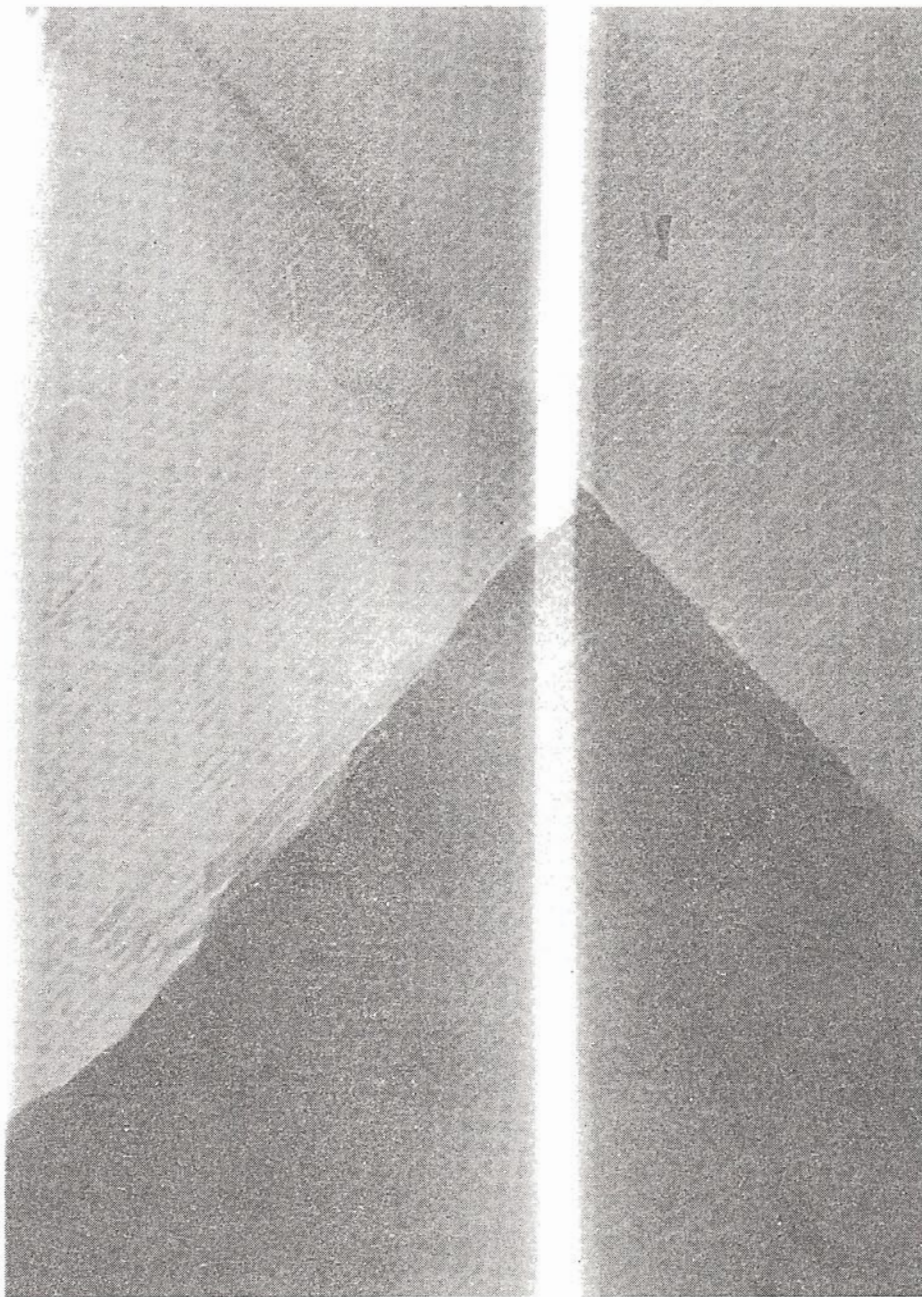
8



9



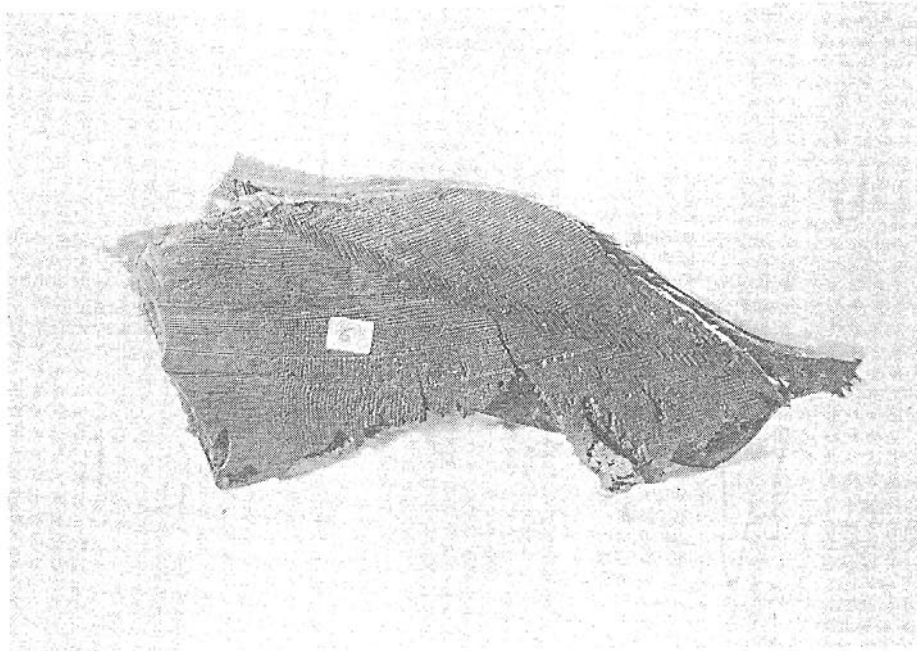
10



11



12



13

1.16.2 D.F.D.R. Study (Digital Flight Data Recorder)

The following table shows the most significant matters resulting from the study of data from the D.F.D.R.:

	Dist. to thres. R. 14 (feet)	Speed IAS (Kts)	Time before impact (sec)
(*) Start of take-off run	242	0	63.75
Final power adjustment	300	-	51.75
80 Kts. IAS speed	1,200	80	45.99
100 Kts. IAS speed	1,870	100	41.21
V1 speed	5,626	162	23.70
upward movement of elevator	5,922	166.7	22.62
VR speed	6,102	169	21.96
downward movement of elevator	6,250	175.07	21.44
(**) start of deceleration	7,054	176.82	18.64
Nose wheel again on ground	7,142	177.80	18.34
Maximum IAS speed reached	7,841	184.75	16.00
Crossing of runway 32 threshold	10,499	122.43	4.75
Impact with the ILS building	11,385	95.08	0

(*) The start of the take-off run is considered to be the moment in which an engine showed a N_1 increase, longitudinal acceleration increase, vertical acceleration increase, and lateral acceleration oscillation and starting of activity.

(**) The start of deceleration is considered to be the moment in which an engine showed N_1 deceleration, decrease of longitudinal acceleration, and decrease in vertical acceleration.

1.17 Additional information.

1.17.1 Human factors.

A period of time passes from the moment in which the pilot's mind registers any information to the time action is taken, during which period the information received is compared to data held in memory, as the result of the comparison decision is taken.

The DECISION TIME is subject to the complexity of the situation and to the number of possible replies. Decisions are not required in those cases involving just one possible action, thus the time of reaction being very short. It is a TIME OF SIMPLE REACTION.

With regard to complex situations involving the possibility of different replies, the TIME OF SIMPLE REACTION must be added to the time of decision to find the total time of reaction.

The short period of time sometimes available to the pilot to take a decision and the impossibility, in some cases, to correct them, requires from these decisions to be fast and correct.

In order for a decision to be adequate it must be based on clear, correct and sufficient information, and in order for it to be fast it must have very little alternatives.

In order to improve the decisions taken by the pilots during the most critical phases of the flight, these decisions are intended to be as simple and automatic as possible. To this end, the pilots are subject to training in flight simulators, in which every known emergency is performed.

With respect to the most critical phase of the take-off, proximity to V_1 , all the airlines train their pilots with a view to solve problems resulting from engine failure. In the case this failure is identified prior to V_1 , the pilot's almost automatic reply is to reject the take-off, and if the identification takes place after V_1 the pilot shall decide to continue the take-off.

Nevertheless the airlines, when this accident occurred, were not training their pilots on how to identify or take action in case of wheel failure and/or strange vibrations. Nor do clear procedures exist for these cases in relation to what to do and how to do it.

In order to solve a problem, the pilot has to be able to perform a clear identification. The majority of emergencies are revealed through lights, acoustic signals, abnormality of instruments, or other information which enable him to clearly establish what is happening. From this moment on, the pilot just has to follow the procedures established in order to face that emergency.

Nevertheless this not always happens. The airplane may reveal the problem to the pilot through information which is confusing or insufficient in order to clearly establish what is happening. This is the case when strange noises and/or irregular vibrations occur.

The worst emergency that a pilot may encounter is that for which he has not been trained. If in addition it becomes difficult to identify and requires an almost instant decision the problem worsens considerably.

An unidentified strong vibration at high speed in the take-off run, with no indication to clarify if it is a problem of wheels, controls or structur-

ral integrity, is a special case of this type of emergencies.

1.17.2 Flap setting for take-off.

The DC-10's operation was based on the determination of the best flap setting for every take-off.

In order to simplify the determination of the flap setting for take-off, some operators have tabulated the airports at which they operate with a small number of settings.

In the case of SPANTAX with respect to Malaga Airport, the flap settings were tabulated at 8 and 15 degrees. Independently of these tables, it included graphs with which the best setting could be calculated.

Thus the crew had three possible flap settings for take-off: 8° , 15° , and optimum flap.

SPANTAX's Flight Manual had been made and updated by United Airlines, U.S.A., by means of a contract established by both airlines. To a great extent, SPANTAX's Manual was a word by word copy of that of United Airlines.

Though the manuals of both airlines, pages 4-6.1 of United's and 4-6 of SPANTAX's, state that "the crew must not arbitrarily presume that flap 8 (flap 5 in United's) is the "normal" setting for

take-off", other paragraph stated that "it is encouraged to use flap 8 (flap 5 in United's) when it is acceptable from an operational's point of view and runway and take-off weight conditions permitting".

Using flap 8, under the conditions in the day of the accident, take-off could be performed with a maximum weight of 558,620 pounds, limited by the runway. The airplane weighed 527,657 pounds, therefore existing a 30,963 pound margin.

Using flap 15, take-off could have been performed with 557,900 pounds, limited by the second segment. There was therefore a 30,243 margin.

The speeds, in knots, for the different options were the following:

With 8⁰ flaps.....: $V_1=162$ $V_R=169$ $V_2=182$

With 15⁰ flaps.....: $V_1=156$ $V_R=164$ $V_2=175$

With 18⁰ optimum flap: $V_1=155$ $V_R=163$ $V_2=174$

Though wheel failure occurred at a speed in which in these three cases it would be on the ground in these three cases, and if rejected take-off would have taken place under the same circumstances, the airplane would have equally overshoot the runway, though at a lower speed using flap 15 or flap 18. It is not possible to establish whether the consequences would have been different, since these were due, possibly, to the rapid fire which

started as a result of the impact with the water pump's concrete construction.

Optimum flap setting was 18 degrees, and if it had been used a greater decrease of take-off speed would have been achieved.

Choosing a low flap setting has the advantage of a greater climb gradient for take-off in case of engine failure on take-off, less fuel consumption and less noise, while having the disadvantage of requiring higher take-off speeds thus the reject of the take-off becoming more critical.

The contrary occurs when using a high flap setting. Take-off speeds are lower, providing a greater margin in case of rejected take-off, but the climb gradient decreases in case of engine failure.

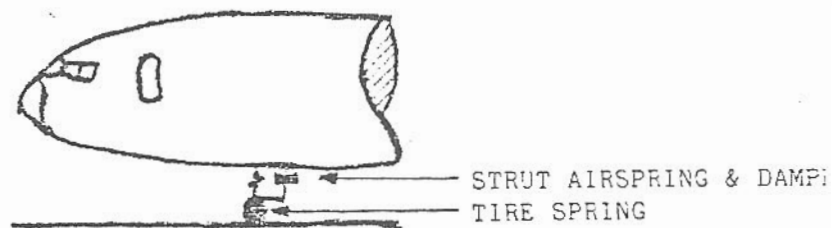
In this case, though it had a great margin with respect to weight limitations either using 8° or 15° flap, it would have been advisable to use the later setting since there were no obstacles in the second segment due to the fact that the take-off was performed towards the sea, and the take-off speed could have been lower.

1.17.3 Theoretical study of the vibrations produced in the cockpit's floor, due to unbalance of a wheel in the nose gear.

A theoretical study was performed using a computer at the Department of Engineering of McDonnell Douglas, in order to establish the periodic acceleration (vibrations) produced in the cabin's floor due to unbalance of a wheel in the nose gear.

This study does not include the evaluation of the sensations which the crew members might have felt through the points of contact with elements of the cockpit.

The theoretical conditions established for this study are the following:



- strut airspring = 8258 lb./inch for half airplane.
- strut damper force = $C_s X^2 = C_L X$
- C_s = Damper coefficient = 37.5 LB/(IN/SEC)² (half airplane).
- X = Velocity of tire relative to cockpit (IN/SEC)
- C_L = Linear approximation for damper
- $C_L = \frac{8WX_0}{3\pi} C_s$ (Frequency and amplitude dependent)
- W = Frequency (RAD/SEC)
- X_0 = Amplitude (IN)
- Tire spring = 10,000 lb/in for half airplane.
- Tire imbalance force = $m r w^2$
- m = mass imbalance
- r = Tire radius = 18 in.

NOTE: Results in vertical and longitudinal forces 90 degrees out of phase.

Graphic and Table of Values obtained, are included in Annex C.

2.- ANALYSIS

2.1 Introduction.

This analysis is exclusively based on data from the DFDR and on statements from the crew and passengers. The CVR tape was totally destroyed due to its prolonged exposure to high temperatures.

The aircraft had scheduled a charter flight, n. 995, from Madrid (Spain) to J. F. Kennedy Airport in New York (U.S.A.), performing an intermediate stop at Malaga.

The crew chose the lower flap setting of the two tabulated (8° , 15°) which figure in the Analysis of Malaga Airport, of SPANTAX Airlines. Nevertheless, although using 8° provided a margin of 38,963 pounds to MTOW (Maximum take-off weight), it would have been advisable to use 15° flaps, or better yet to choose optimum flap, since this would have allowed lower take-off speeds thus providing a greater margin specially when facing problems other than engine failure.

The speeds calculated and used by the crew with 8° flap, were in accordance with the Manual, and were the following: V_1 : 162 knots; V_R : 169 knots; and V_2 : 182 knots.

The airplane was taxiing at a normal speed from the international parking area at Malaga Airport, to the threshold of runway 14.

The crew carried out the required check lists, and established the functions to be performed by each one of them during take-off.

While taxiing, the aircraft received the appropriate ATC and take-off clearances.

Line up with the runway was normal and take-off started from a static position, using the engines' full power.

The co-pilot called out the 80 knots and 100 knots speeds, and the flight engineer reported engine parameters as correct.

A short time before reaching V_1 , pieces of the tread of tire started to detach from the nose wheel in position 2.

At or close to V_1 , a strange vibration could be felt in the airplane.

According to DFDR data, a normal acceleration of the airplane can be observed during the take-off run.

At a speed in between 152.0 and 175.75 knots, data out of synchronization appeared on the DFDR, which had to be recovered through launching of bits. This period coincides with the time in which according to statements from the crew and their reactions, the vibration was perceived.

The beginning of a rise in the elevator is noticed at a speed of 166.7 knots.

At 175.07 knots, appears a movement in the elevator in the opposite direction, which may be considered as probable the time when the captain began the reject of the take-off.

The remains of the tire found on the runway after the accident, appear first approximately 5,650 feet from the threshold of runway 14, ending 7,350 feet away from the same.

2.2 Reject of the take-off.

The vibration was increasing and when the captain, once V_R was reached, tried to take off, it was of such a magnitude that believing that the airplane would become uncontrollable, he decided to reject the take-off.

The pilots were trained to consider V_1 as the speed at which a reject of the take-off should be started and, though he was taught in relating this speed with engine failure, and was not trained to know the possible impairment the stop distance might suffer when failure is due to other factors, he is minded to take off with the flaws detected after V_1 except when these prevent the airplane from flying.

In the case of this accident the influence of the pilot's training is observed when, once he had noticed the anomaly over V_1 , the strong vibration in the airplane, he decided to continue the take-off.

Between V_1 and V_R , the pilot registered information on the anomaly of the airplane which was totally new to him and that did not allow him to identify the true cause of the same.

Nevertheless his training and experience impelled him to go ahead with the take-off.

When once V_R was reached, he began to rise the nose gear in order to take off, several things happened simultaneously:

- a) the vibration was highly increased;
- b) due to the position of the pilot's seat with respect to the nose leg, he felt as if the vibration came from the rear, towards the tail;
- c) he did not feel the vibration on the pedals, as it usually occurs when there are wheel problems, but mainly on the control bar in a lateral manner.

The system man/machine, requires communication between both of its components. Man sends information to the machine through the controls. The machine sends information to man through the display of the situation: instruments, lights, noises, and actuation. Man registers this information through his senses making a whole with data already in his mind in order to take the appropriate action.

In order for these decisions to be correct, the transmission of information from the machine to man must be clear and correct, on the contrary, the decision might be erroneous. In this case, the pilot received one information from the machine, on rotation, which led him to think that the airplane was uncontrollable, thus he decided to reject the take-off.

His decision to stay, since it was against his learning, once passing not only V_1 but V_R , must have taken him more

time that if he had faced a known situation for which he had been trained.

In this case, since the situation was not clearly displayed by the machine and since it had to overcome the pilot's natural reluctance to reject the take-off after V_1 , it could have meant a time of decision even longer.

Once the decision had been taken, while lowering the nose wheel and beginning to stop the aircraft, this was still accelerating.

Taking into account that when reporting V_R , the airplane's speed was of 169 knots, that the increase in the intensity of the vibration was subsequent to the rise of the nose wheel and that the maximum speed attained was of 184.75 knots, the captain's time of reaction should be considered normal, in view of the particular circumstances of this case.

The high speed at which the reject of the take-off took place and the short runway remaining, created an irregular situation which explains the differences existing between the way the airplane was stopped and that practiced in the simulator.

During the take-off, the captain has his right hand on the power control until V_1 is reported. This way, any reject decision taken before reaching this speed implies the immediate action of cutting power at the same time brakes are applied at maximum level.

When V_1 is reported, the captain transfers his right hand from the power control to the control column. This means he will go ahead with the take-off, and at the same time, avoids the possibility of retreating inadvertently the power control during rotation and first segment of the climb.

On rejecting the take-off once rotation had begun, the captain had to rapidly transfer his hand from the stick to the engine throttles, to shut it off. When he was setting the throttle back the throttle and trying to turn on the reverse, engine n. 3 throttle lever slipped from his hand. The power's asymmetry deflected the airplane slightly to the left, the spoilers did not come out immediately probably because the reverse cycle had not yet been completed, having to take them out manually. This might have commanded his attention for a few seconds so that when, according to the statements of the captain, he saw the ILS building to his right, as a consequence of the deviation suffered by the airplane to the left, he concentrated in trying to control its direction while trying to stop it, and seeing he was going to overshoot the runway he ordered to shut the engines off (Annex D).

2.3 Evacuation.

Evacuation could not be ordered because the airplane had lost electrical current and because it did not have an evacuation warning system which is not compulsory in the present regulation. Nevertheless, in view of the accident, and once the airplane stopped, the Assistant Crew opened the doors and ordered the passengers to leave the aircraft. The loud speakers were not used since there was a great difficulty in reaching them.

Doors 1L, 1R and 2L were opened and used immediately.

Though the stewardess in charge of opening door 3L saw fire on the left side, she decided to open it on seeing fire was greater on the right side.

The stewardess in charge of opening door 2R, on seeing there was fire outside, decided not to open it, conducting the passengers to door 2L. Later on, a passenger opened it,

and once 3 or 4 passengers had gone out, the slide became unusable by the fire which then began to invade the cabin.

The stewardess in charge of opening door 3R decided not to open it due to the fire outside, and believing the fire to be on the right side, conducted the passengers towards door 3L.

On account of passengers' statements, we know that the three stewardesses at the rear of the airplane tried to open doors 4L and 4R, but failed probably due to structural deformation, as a consequence of impacts of caused by the fire.

The 91 passengers in the first cabin left the airplane through doors 1L, 1R, and 2L.

The 122 passengers in the second cabin left the airplane through doors 2L, 3L, and a small number of passengers used 2R.

167 passengers occupied the third cabin. The 117 of them who could leave the airplane did it mainly through door 3L, which was affected by fire during almost the whole of the evacuation process and whose slide soon became unusable.

The 47 passengers and 3 crew members who died, occupied cabin number 3.

Some statements indicate that fire and dense smoke invaded the tail of the airplane, probably because of the breakage of the top part of the passenger department, beside door 4R. This probably caused the fast incapacitation of the three stewardesses beside doors 4L and 4R, reason by which they could not conduct the evacuation process in their zone, nor notify to the rest of the crew the problems they were having.

Evacuation was slow in cabins one and two because the passengers, who embarked the aircraft with a great deal of hand luggage, remained collecting the same before leaving the airplane.

In cabin number three, apart from the hand luggage problem, a jam occurred due to the great number of passengers trying to leave the airplane via the left corridor, bound to door 3L, where evacuation was difficult on account of the slide's destruction caused by the fire.

The invasion of fire and smoke was the cause for the incapacitation of the victims who were trapped inside this cabin.

The lack of visibility, due to smoke and fire, as well as the screens between cabins, prevented the passengers from having an overall view and in fact, three different evacuations took place, one in each cabin.

Though the aircraft evacuation certification contemplates a 50% failure of the exits, and in this case half of them could be used, this accident questions the possibility of compliance with the 90 second evacuation requirement, in case the four rear doors are unserviceable.

2.4 Wheels

The appropriate inspections were carried out at the technical stops performed in Malaga and Madrid, finding no anomalies. Wheel pressure was checked before leaving Palma,

and they were all within the rules. It was observed that the wheels were in a good condition.

The study of the remains of the tire detached during the take-off run, and which could be recovered, reveals defects in the retread process, low adhesion flaws between the different layers, different levels of impregnation of the cord weaving in some of the layers, irregular attachment of an intermediate rubber strip which partially covers the carcass and over which the retread process began, and bubbles appear in certain zones as a consequence of an improper execution of the said retread process.

The same study shows as well that detachment of pieces of the tread of tire occurred in a sequenced manner, some of them remaining joined to the carcass during a period of time, before they finally detached.

Strong vibrations occurred which could not be identified by the crew.

3.- CONCLUSIONS

3.1 Findings.

- a) The captain and the crew had the appropriate ratings, experience and were physically well.
- b) The airplane included valid Airworthiness Certificate, Registration Certificate and Maintenance Certificate. The records show it was properly maintained in accordance with the authorised maintenance schedule.
- c) The investigation did not reveal evidence of irregularity in the operation of engines and aircraft systems.
- d) The weight and balance of the aircraft were within the fixed limits.
- e) Take-off speeds calculated by the crew were in accordance with flap settings chosen pursuant to the Operations Manual.
- f) Take-off was normal until vibration began prior to V_1 .
- g) Vibration caused by detachment of the tread of tire of tire n. 2 of the front gear, increased significantly when rotation began.

- h) Detachment of the tread of tire n. 2 of the front gear, was caused by flaws in the retread process.
- i) The crew had no indication to identify the origin or cause of the vibration.
- j) The captain decided to reject the take-off at a speed over V_R , when vibration highly increased considering it was caused by some kind of failure which would make the aircraft uncontrollable.
- k) The position of the remains of the tread of tire shows that its detachment began at, or before, V_1 , ending after V_R .
- l) Once the reject of the take-off had begun, n. 3 engine remained with a positive thrust.
- m) N. 3 engine detached from the airplane when it collided with the ILS building.
- n) Fire began as a consequence of the impact and breakage of the right wing on colliding with the concrete structure placed on the other side of the highway.
- o) Evacuation was rendered difficult due to invasion of smoke and fire in the rear of the airplane, and because three of the four doors in cabin n. 3 became unusable.

3.2 Cause

The Commission determines the cause of the accident to be the fractional detachment of the retread of the right wheel of the nose gear, originating a strong vibration which could not be identified by the captain, leading him into the belief that the aircraft would become uncontrollable in flight, and thus deciding to abandon the take-off over V_R .

The decision of aborting the take-off, though not in accordance with the standard operation procedures, is in this case considered reasonable, on the base of the irregular circumstances that the crew had to face, the short period of time available to take the decision, the lack of training in case of wheel failure and the absence of take-off procedures when failure other than that of the engines occurs.

4.- RECOMMENDATIONS

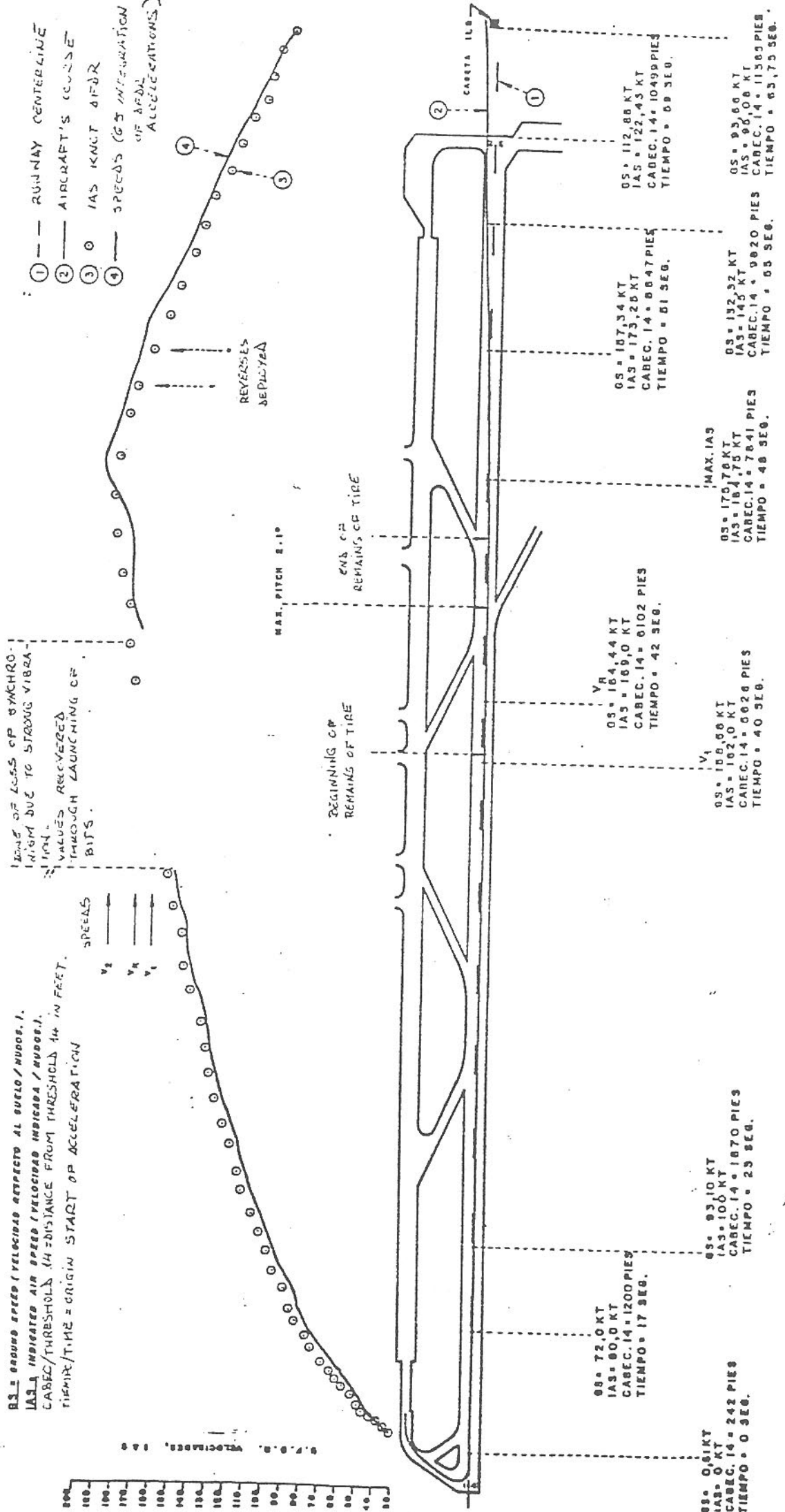
- 1) Pilots should be trained on failure other than that of engines, particularly failure related to problems in the landing gear occurring at speeds close to V_1 , as well as reconsidering V_1 's philosophy when braking capability is somehow hampered.
- 2) The use of retreaded wheels should be clearly regulated.
- 3) The possibility of installing in the cockpit an indicator to inform the pilots on the conditions of the tires and control surfaces should be studied.
- 4) It should be regulated that constructions in the prolongation of the runway, at the airport area, should be frangible on a strip 60 meters wide along both sides of the prolongation of the centerline.
- 5) The certifications of airplanes with several passenger departments should consider the possibility of the evacuation having to be performed when 50% of the exits are made unusable.
- 6) Loud speakers and other articles destined for evacuation should be placed beside the seats of the Assistant Crew.
- 7) Training of crews relating evacuation of wide body airplanes should be modified, due to the decrease of visibility of the whole of the cabin which makes coordination difficult in critical cases.

- 8) Strict compliance with hand luggage rules should be demanded from the passengers and from the personnel in charge of embarkation.
- 9) Unnecessary low flap settings on take-off should be avoided. The airlines should have clearly established in their Flight Manual the most convenient flap settings for each case.

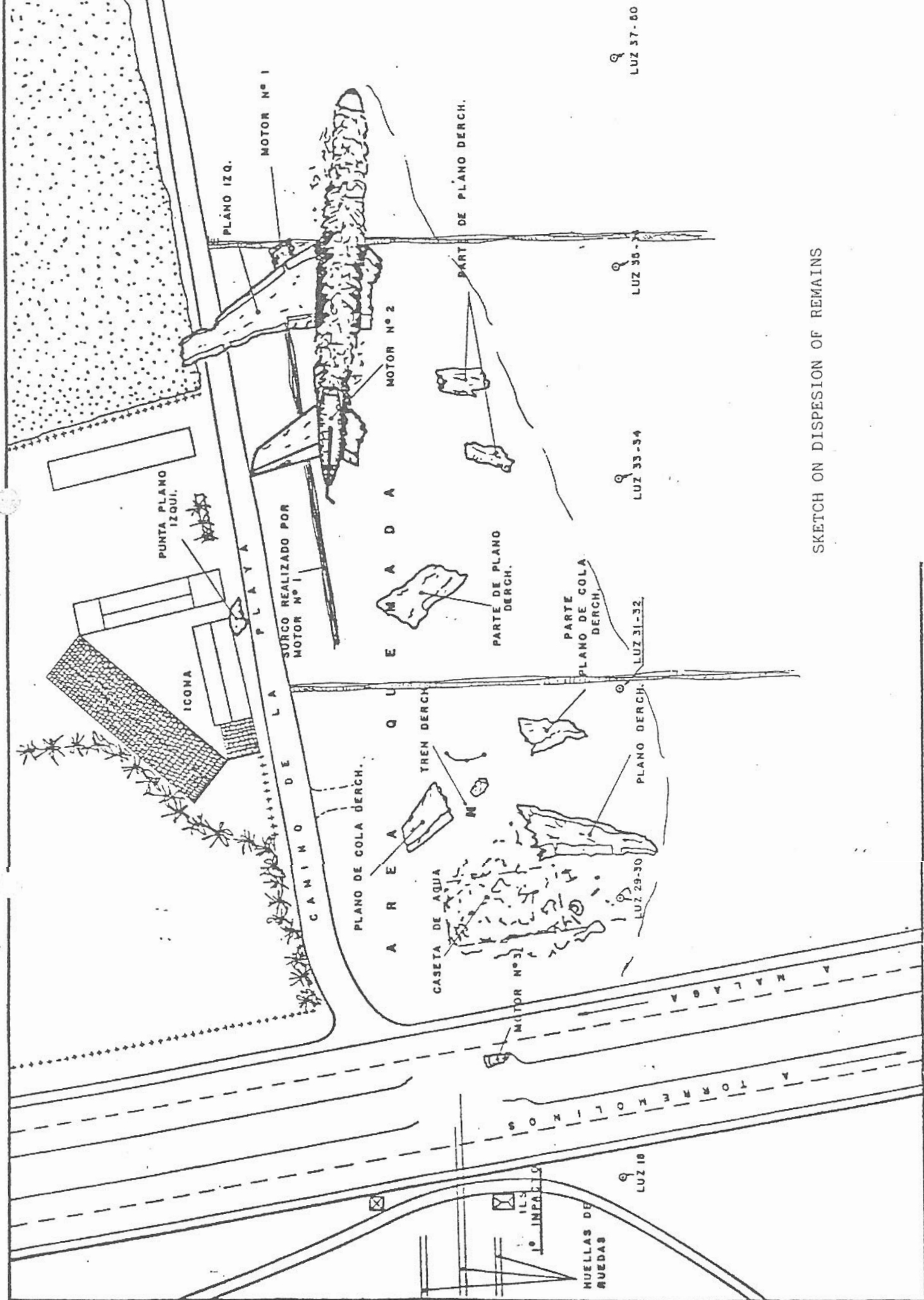
ANNEX A

AIRCRAFT'S COURSE

SPEED PROFILE



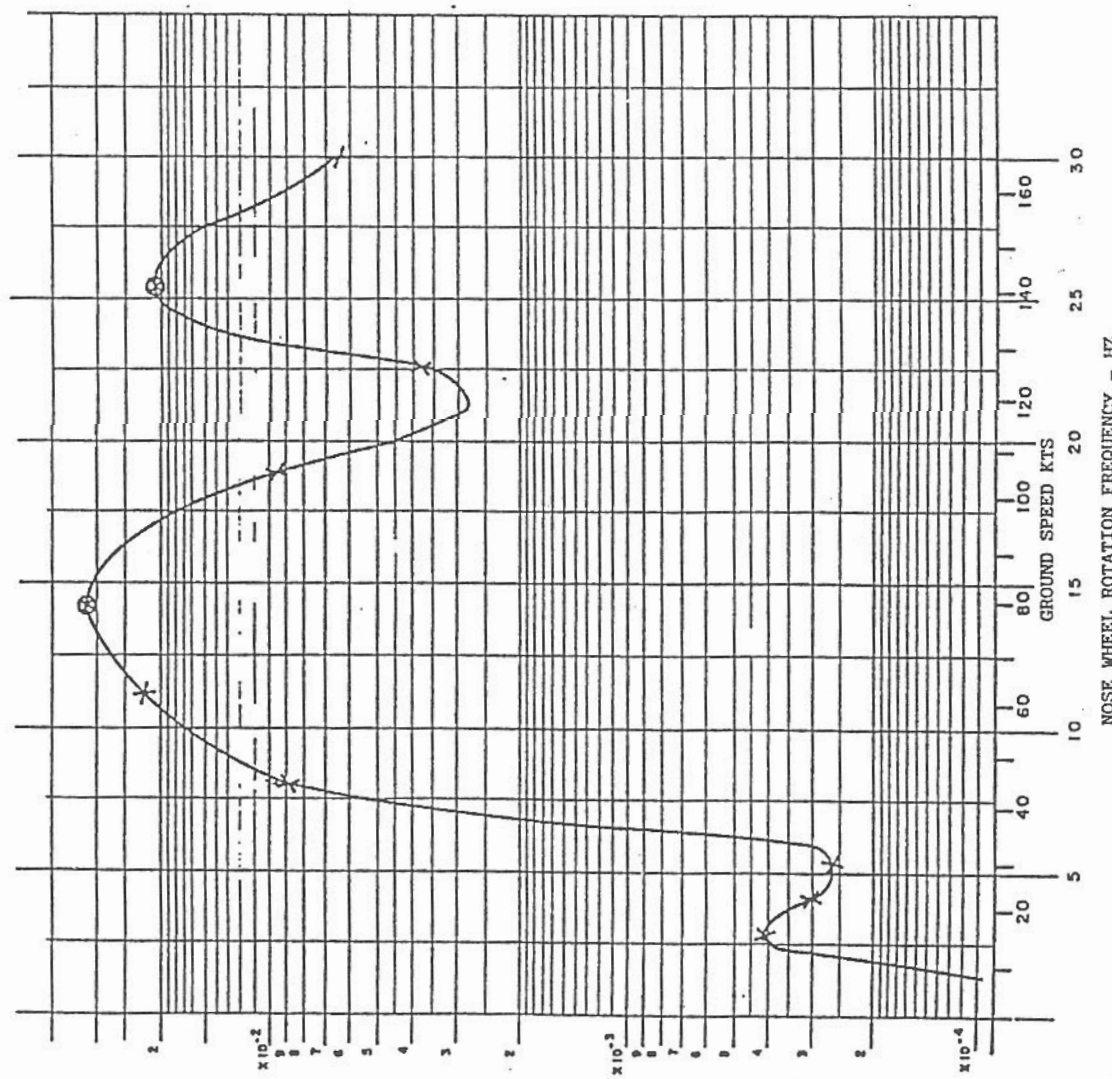
ANNEX B



SKETCH ON DISPESION OF REMAINS

ANNEX C

ESTIMATED COCKPIT FLOOR VIBRATION FOR NOSE TIRE IMBALANCE ACCELERATION VS GROUND SPEED (DC-10-30)



COCKPIT VERTICAL VIBRATION O-PEAK G's

MODAL DATA
DC-10-30 NOSE GEAR IMBALANCE ANALYSIS

MODE NO.	FREQ. (HZ)	HALF AIRPLANE GENERALIZED MASS (LB-IN-SEC ²)		COCKPIT VERT. +DWN (IN.)		NOSE WHEEL VERT. +DWN (IN.)		FORE/AFT +FWD (IN.)
		FREQ. (HZ)	MASS	COCKPIT VERT. +DWN (IN.)	NOSE WHEEL VERT. +DWN (IN.)			
1	0.0	727.0	1.00	1.00	1.00	0.0	0.0	0.0
2	0.0	132.1	0.898	0.898	0.708	-0.189	-0.189	-0.189
3	0.0	727.0	0.000	0.000	0.000	1.0	1.0	1.0
4	1.20	11.28	0.00649	0.00649	-0.00140	-0.00700	-0.00700	-0.00700
5	1.92	38.16	0.00860	0.00860	0.00676	-0.00100	-0.00100	-0.00100
6	2.74	23.68	0.406	0.406	0.279	-0.118	-0.118	-0.118
7	3.41	27.70	0.184	0.184	0.122	-0.0790	-0.0790	-0.0790
8	3.72	5.346	0.0657	0.0657	0.0359	-0.0250	-0.0250	-0.0250
9	3.88	13.83	0.0205	0.0205	0.0139	0.0370	0.0370	0.0370
10	4.11	3.045	0.0783	0.0783	0.0450	-0.0310	-0.0310	-0.0310
11	4.71	522.0	0.102	0.102	0.0529	-0.0260	-0.0260	-0.0260
12	5.35	43.20	0.177	0.177	0.0947	-0.0520	-0.0520	-0.0520
13	7.14	6.341	0.0170	0.0170	0.00497	-0.00800	-0.00800	-0.00800
14	7.87	10.49	0.322	0.322	0.130	-0.199	-0.199	-0.199
15	9.00	65.61	0.0761	0.0761	0.0310	-0.0260	-0.0260	-0.0260
16	10.62	9.880	0.117	0.117	0.0330	-0.109	-0.109	-0.109
17	11.10	2.021	0.0193	0.0193	0.00503	-0.0190	-0.0190	-0.0190
18	11.27	17.00	0.315	0.315	0.0911	-0.186	-0.186	-0.186
19	11.85	15.47	0.104	0.104	0.262	-0.0680	-0.0680	-0.0680
20	13.14	4.057	0.0501	0.0501	0.0122	-0.0310	-0.0310	-0.0310
21	14.24	4.677	0.139	0.139	0.0281	-0.0950	-0.0950	-0.0950
22	15.28	43.20	0.0380	0.0380	0.00544	-0.0310	-0.0310	-0.0310
23	15.96	8.410	0.0770	0.0770	0.0117	-0.0530	-0.0530	-0.0530
24	16.27	3.521	0.103	0.103	0.0146	-0.0710	-0.0710	-0.0710
25	17.62	238.2	0.0699	0.0699	0.0223	-0.0630	-0.0630	-0.0630
26	18.86	18.22	0.272	0.272	0.0223	-0.176	-0.176	-0.176
27	22.37	27.32	0.441	0.441	-0.00940	-0.135	-0.135	-0.135
28	25.11	91.29	0.961	0.961	-0.0900	-0.709	-0.709	-0.709
29	13.00	0.04119	0.0	0.0	0.0	0.0	0.0	0.0

NOTE: Modal data are for a GW = 561,000 lbs. and a C.G. = 14% MAC.
Reference Model No. 17351

X = Analysis relative maximums/IN-LB half airplane imbalance nose tire off ground without damper.
O = Same analysis as above with strut damping.

ANNEX D

CF6-50C1 ENGINES
8-DEGREE FLAP
SLATS EXTENDED

CONDITIONS:

AIRPORT PRESSURE ALTITUDE = -190 FEET
 AIRPORT AMBIENT TEMPERATURE = 25°C
 RUNWAY SLOPE = -0.002
 REPORTED WIND AT 50-FOOT HEIGHT =
 14 KNOTS HEADWIND
 11.6 KNOTS AT AIRPLANE HEIGHT
 WEIGHT = 527,657 POUNDS
 NO ICE PROTECTION
 ENGINE BLEED FOR AIR CONDITIONING ON

- 1 — DATA BASED ON INTEGRATION OF DFDR ACCELEROMETERS
- 2 ○ DATA BASED ON DFDR INDICATED AIRSPEED CORRECTED TO GROUND SPEED
- 3 — PREDICTED ACCELERATION DATA CALCULATED FOR ACTUAL CONDITIONS USING FAA MANUAL N_1 AND MINIMUM THRUST
- 4 — PREDICTED STOPPING DATA CALCULATED FOR ACTUAL CONDITIONS FROM $V_1 = 162$ KNOTS. IAS USING CALCULATION METHOD OF FAA MANUAL
- 5 — PREDICTED ACCELERATION DATA CALCULATED FOR ACTUAL CONDITIONS WITH N_1 FROM DFDR AND AVERAGE ENGINE THRUST
- 6 — CALCULATED MAXIMUM STOPPING FROM DFDR THROTTLE CHOP, USING PERFORMANCE MANUAL $RTO \mu$ AND 3-ENGINE MAXIMUM REVERSE THRUST TO STOP

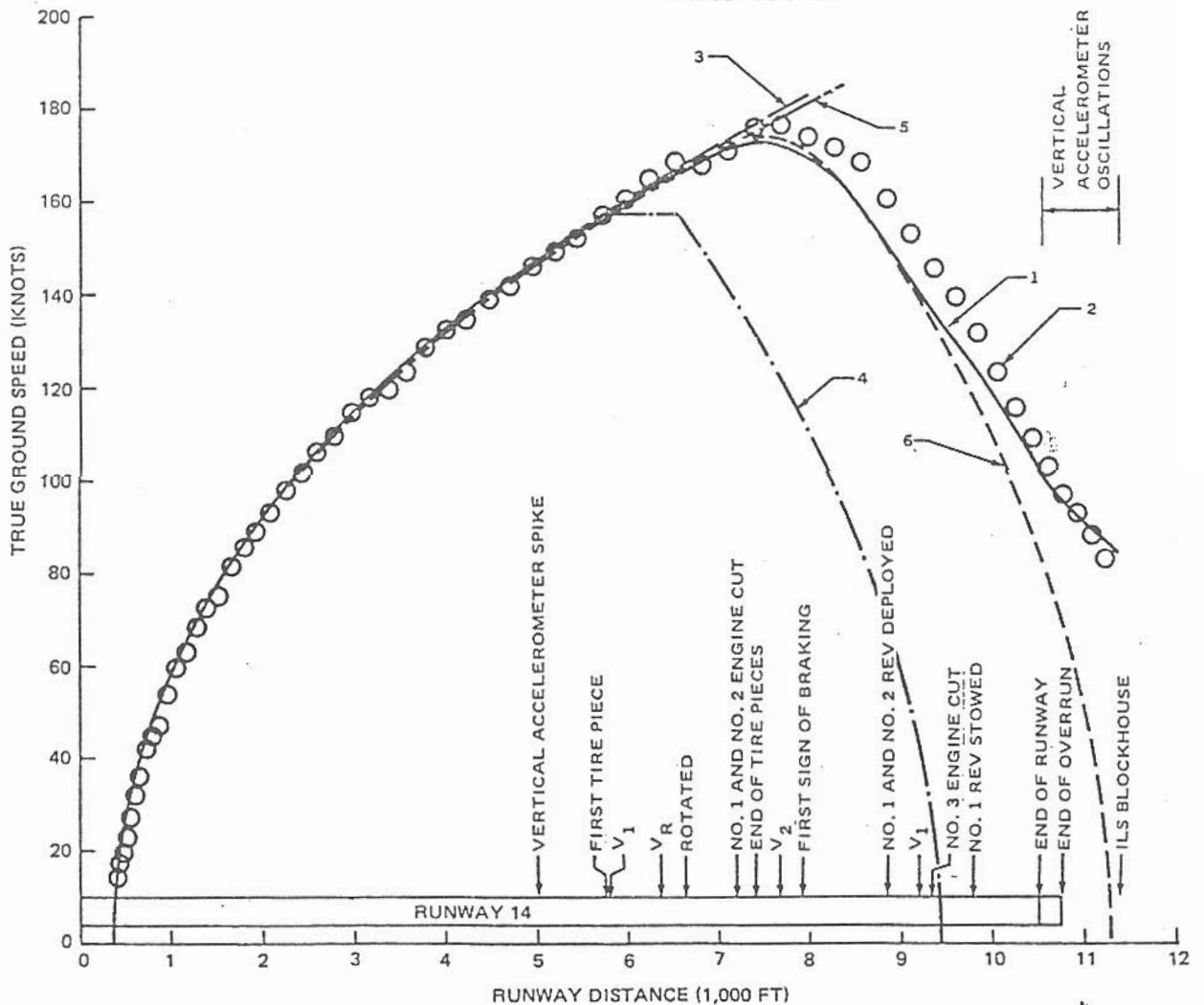


FIGURE 4. MODEL DC-10-30 SPANTAX SHIP 238 RTO SPEED VERSUS DISTANCE