AIRCRAFT ACCIDENT REPORT 9/82

Accidents Investigation Branch

Department of Trade

BRITISH AIRWAYS TRIDENT G-AWZT
INEX ADRIA DC9 YU-AJR

Report on the collision in the Zagreb area, Yugoslavia, on 10 September 1976

**Reprint of the report produced by
The Yugoslav Federal Committee for
Transportation and Communications
Second Commission of Inquiry with
United Kingdom Addendum**

In accordance with the provisions of Annex 13 of the Convention on International Civil Aviation, an accredited representative of the United Kingdom participated in the investigation of this accident. Responsibility for the conduct of the investigation and the content of the report was that of the Second Commission of Inquiry convened by the Yugoslav Federal Committee for Transportation and Communications.

LONDON
HER MAJESTY'S STATIONERY OFFICE

List of Aircraft Accident Reports issued by AIB in 1982/83

No	*Short Title*	*Date of Publication*
11/81	Piper PA 38–112 Tomahawk G–BGGH Wood Farm, Kiddington, Oxfordshire May 1980	February 1982
1/82	Pilatus PC–6/B2–H2 Turbo Porter G–BHCR Peterborough (Sibson) Aerodrome February 1981	April 1982
2/82	McDonnell Douglas DC10–30 N 83 NA London Heathrow Airport September 1980	September 1982
3/82	Maule M–5–235C G–LOVE Cranfield Aerodrome Beds September 1981	September 1982
4/82	Cessna Citation 500 G–BPCP St Peters Jersey Channel Islands October 1980	November 1982
5/82	Piper PA28 (Cherokee) G–AVBJ and G–AXZC Hamble Aerodrome Hants April 1981	October 1982
6/82	Lockheed Jetstar 1329–N267L Luton International Airport March 1981	January 1983
7/82	Britten–Norman Islander BN2A G–BBRP Netheravon Aerodrome Wiltshire February 1982	February 1983
8/82	Agusta Bell 206 B Jetranger G–BEKH Dundee Scotland December 1980	April 1983
9/82	British Airways Trident G–AWZT Inex Adria DC9 YU–AJR Zagreb Yugoslavia September 1976	
10/82	Bell 212 G–BIJF in the North Sea SE of the Dunlin Alpha platform August 1981	
1/83	Wasp Falcon IV Powered Hang Glider Wittenham Clumps, nr Didcot May 1978	

ISBN 0 11 513511 1

COMMISSION FOR RE–OPENED INVESTIGATION OF THE ACCIDENT OF THE TRIDENT THREE AIRCRAFT G–AWZT AND THE DC–9 AIRCRAFT YU–AJR ABOVE ZAGREB VOR

COMMISSION REPORT

Belgrade, February 1982.

TABLE OF CONTENTS

Page

INFORMATION ABOUT THE AIRCRAFT AND ACCIDENT

a)	Type of aircraft:	TRIDENT THREE
	Registration marks:	G–AWZT, series no. 2320, BE 476
	Owner:	British Airways, London
	Date and time of accident:	10 September 1976 at 10.14'41" (GMT)
	Place of accident:	Over Zagreb VOR in vicinity of Vrbovec, Socialist Republic of Croatia
b)	Type of aircraft:	DC–9
	Registration marks:	YU–AJR, series no. 47649, JP 550
	Owner:	Inex Adria Airways, Ljubljana
	Date and time of accident:	10 September 1976 at 10.14'41" (GMT)
	Place of accident:	Over Zagreb VOR in vicinity of Vrbovec, Socialist Republic of Croatia

1. INFORMATION ABOUT THE ACCIDENT

1.1. HISTORY OF THE FLIGHT

a) Trident Three Aircraft

The Trident Three was on a scheduled flight (Bealine 476) from the airport Heathrow – London (England) to Istanbul (Turkey) carrying 54 passengers and a crew of 9.

The Trident Three aircraft took off from Heathrow airport at 08.32 (GMT). The flight BE 476 proceeded via West Europe and a portion of the airway UB5 above Yugoslavia until the collision near Zagreb with DC–9 aircraft of INEX ADRIA, flight JP 550.

First contact with the Area Control Centre "Upper Sector" in Zagreb was established on the frequency 134,45 MHz at 10.04'12" GMT. The conversation was: "Zagreb, Bealine 476, good afternoon". Zagreb response was: "Bealine 476, good afternoon, go ahead".

10.04'19" BE 476: 476 Klagenfurt at 02, 330 estimating Zagreb at 14.
Zagreb: Bealine 476, roger, call me passing Zagreb, flight level 330, SQUAWK Alfa 2312[1)]

10.04'40" BE 476: 2312 is coming

No further calls were received from the Bealine 476 aircraft which was obliged to keep active listening at the frequency of 134,45 MHz.

Immediately after the report to Zagreb Control, the crew heared a Turkish Airlines aircraft reporting to Zagreb Control its position over point "Charile" (just ahead of the Trident aircraft) at flight level 350. The cockpit voice recorder on th TRIDENT THREE recorded the comments of the crew that shortly afterwards they saw the aircraft passing overhead in the opposite direction.

The aircraft maintained a heading of 120 – 122^{o} until 2 min. 50 sec., before ZAG VOR at flight level 330, recorded indicated airspeed (hereinafter speed) 295 Kts, Ground speed = 489 Kts (905 km/h).

The aircraft flew along the airway centreline with slight side deviation (1–2 km) to the right due to wind of 220^{o}/45 Kts (measured at 12.00 hours) and probably due to tolerance in the existing characteristics of ZAG VOR.

At 2 min. 50 sec. before the collision, the aircraft changed heading to 115^{o}. Five second before the collision the heading vas 116^{o}, and it was maintained until the collision. From plotted data it could be concluded that at the moment of collision the aircraft was 1.5 – 2 km. north-east of the high cone of ZAG VOR at flight level 330 and at a speed of 295 Kts (IAS).

---

1) SQUAWK Alfa 2312 means: select the secondary radar transponder to Mode/Code Alfa 2312. Upon selecting, the radar display at the controller's position shows a symbol of the aircraft and the number A/2312 and flight level 330 below it. On the basis of this information the controller identifies the aircraft.

The collision between BE 476 and JP 550 occured after JP 550 reported maintaining precisely flight level 330. On the basis of analysis of the cockpit voice recorder tape from the TRIDENT THREE it was established that the accident occured at 10.14'41".

Examination of the wreckage showed that the left wing of the DC–9 cut through the flight deck and forward passenger compartment of the TRIDENT.

b) DC–9 Aircraft

The crew (5 members) of the DC–9 aircraft had a task to transport a group of 108 West German tourists from Split to Cologne.

The flight JP 550 took-off from Split airport at 09.48 (GMT).

In coordination between the Approach Control in Split and the Area Control Centre in Zagreb – "Lower Sector East", the aircraft JP 550 was cleared to climb to flight level 180 under the condition to be overhead Split VOR at flight level 120.

After take-off the aircraft climbed until Split VOR and 7 minutes later, reaching flight level 130, it switched to frequency 124.6 MHz of the Area Control Centre in Zagreb – "Lower Sector East" as follows:

09.54'49"	JP 550:	Dobar dan Zagreb, Adria 550. (Good morning Zagreb, Adria 550), crossing 130, climbing to 180, heading Kostajnica.
	Zagreb:	Roger, recleared 240, Adria 550.
09.55'01"	JP 550:	Recleared 240.

The aircraft JP 550 proceeded climbing to the cleared flight level 240 along the airway B9 maintaining heading from 359° to 004° with average recorded speed of 285 Kts.

09.55'05"	Zagreb:	Adria 550, recleared 260, call crossing 220.

As the crew did not call back, Zagreb Control called again:

09.56'02"	Zagreb:	Adria 550, Zagreb.
09.56'06"	JP 550	550, cleared 260 and call you crossing 240, do you read me?
09.56'12"	Zagreb:	Call me crossing 220
09.56'15"	JP 550:	I will call you crossing 220.

After about 3,5 minutes ATC Zagreb required a flight level check.

09.59'53"	Zagreb:	Adria 550, level check.
	JP 550:	Crossing 183
	Zagreb:	Thanks

Crossing flight level 220, required by ATC, the crew reported as follows:

10.02'44"	JP 550:	Zagreb, Adria 550 crossing 220.
	Zagreb:	Zagreb, 135,8 Good day.
10.02'50"	JP 550:	Good bye.

From this moment the aircraft JP 550 switched to operation with the "Middle Sector" on the frequency 135.8 MHz which is responsible for safety and regulation of traffic between flight levels 250 and 310.

10.03'21" JP 550: Dobar dan Zagreb, Adria 550
(Good morning Zagreb, Adria 550),
crossing 225, climbing 260.

10.03'28" Zagreb: 550, good morning, SQUAWK Alfa 2506, continue climb to 260.

Approximately 18 min. after take-off the aircraft levelled out at flight level 260, heading 359° and speed of 316 Kts. At 10.04 hours the aircraft was to the south from Kostajnica (62 km.). At that time, BE 476 was crossing the Yugoslav-Austrian border.

The crew of the DC–9 aircraft reported to the ATC "Middle Sector" as follows:

10.05'57" JP 550: Adria 550, levelling 260, standing by for higher.
10.06'03" Zagreb: 550, sorry 330 ... e ... 310 is not available, 280 also, are you able to climb may be to 350?
10.06'11' JP 550 Affirmative, affirmative, with pleasure.

The aircraft was retained 1 min. 48 sec. at flight level 260 in a horizontal flight and only then it was cleared to climb to flight level 350 as follows:

10.07'40" Zagreb: Adria 550, recleared flight level 350.
10.07'45" JP 550: Thank you, climbing to 350. Adria 550.

Immediately after this transmission, Zagreb Middle Sector Assistant Controller telephoned to ATC Vienna that JP 550 would be at flight level 350. Vienna acknowledged affirmatively.

At 10.09'18" Zagreb Control informed JP 550, under radar supervision, that it was approaching Kostajnica, that it should proceed to Zagreb and Graz and report passing flight level 290. The crew acknowledged affirmatively.

The aircraft assumed a heading of 353° and a speed of 273 Kts. towards Zagreb VOR, passing abeam and to the west of the KOS NDB, approximately 2–3 km. from the airway centreline.

10.09'49" JP 550: Zagreb, Adria 550 is out of 290.
10.09'53" Zagreb: Roger, call me crossing 310, now.
10.09'55" JP 550: Roger.

The aircraft was climbing 2 minutes and 14 seconds from flight level 290 to flight level 310 maintaining constantly the same flight elements.

Flying on this heading it had slightly diverted to the right, crossing the airway centreline towards Zagreb VOR.

10.12'03" JP 550: Zagreb, Adria 550 out of 310.
10.12'06" Zagreb: 550, for further Zagreb, 134,45 MHz SQUAWK stand by, and good day, Sir.
10.12'12" JP 550: SQUAWK stand by 134,45 MHz. Good day.

When the JP 550 switched to operation on the frequency of 134.45 MHz, the Upper sector control was very busy in conversation with other aircraft. There were four aircraft in radio communication and in addition from 10.13'30" there was a telephone conversation with Belgrade in connection with the transfer of two aircraft flying to Sarajevo and proceeding to Kumanovo.

One minute and 52 sec. passed from the time of the last transmission by JP 550 with the Middle sector to the time when the first contact was established at 10.14'04" with the Upper sector. In this period 8 messages were transmitted by Zagreb control "Upper sector" and 11 various information received.

It was established (on the basis of tape transcription) that though the "Upper sector" of ATC Zagreb was busy in the mentioned period of 1 min. and 52 sec., the pilot of JP 550 had a chance to establish a communication with the "Upper sector" during four pauses in radio communication which lasted 31 sec. all together (first pause – 5 sec., second – 6 sec., third – 13 sec., fourth – 7 sec.).

The flight JP 550 established its first contact with the "Upper sector" as follows:

10.14'04"	JP 550:	Dobar dan Zagreb, Adria 550. (Good morning Zagreb, Adria 550).
10.14'07"	Zagreb:	(Adria 550. Zagreb dobar dan (good morning). Go ahead.
10.14'10"	JP 550:	325 crossing, Zagreb at 14'.

This message reported to ATC indicated that the aircraft was crossing flight level 325 and that it would be at Zagreb VOR at 10.14', continuing its previously cleared climb to flight level 350.

10.14'14"	Zagreb:	What is your present level?
10.14'17"	JP 550:	327.

With this message inclusive, the English phraseology was used and afterwards the conversation was held in the Serbo-croatian language.

10.14'22"	Zagreb:	(Stuttering) ... e ... zadržite se sada na toj visini i javite prolazak Zagreba. (... e ... maintain now that level and report passing Zagreb).
10.14'27"	JP 550:	Kojoj visini? (What level?)
10.14'29"	Zagreb:	Na kojoj ste sada u penjanju jer ... e ... imate avion pred vama na ISN (unintelligible) 335 sa leva na desno. (At which you are now climbing, because ... e ... you have an aircraft in front of you at ISN (unintelligible) 335 from left to right.
10.14'38"	JP 550:	O.K. ostajemo tačno 330. (O.K. maintain precisely 330).

This was the last message from the aircraft JP 550.

The Flight Data Recorder readout shows that before the collision the aircraft was in horizontal flight at a speed of 261 Kts., flight level 330.

At 10.15'06" Zagreb called the crew of BE 476 to report passing Našice. The crew did not respond to this message because the collision between BE 476 and JP 550 had already occured.

The collision was seen by the crew of a Lufthansa aircraft which was operating along UB 5 in the direction of ZAG VOR some 15 NM behind the TRIDENT at flight level 290. According to the statement of the B-737 pilot-in-command Mr. JOE KROESE, his co-pilot saw the collision as a flash of lightning and afterwards out of a ball of smoke, two aircraft falling towards the ground.

From 10.15'36" until 10.18' hours the crew of the Lufthansa aircraft reported several times to the Middle Sector Controller the sighting of a mid-air collision. Captain of the Lufthansa aircraft repeated his message several times on the request of Zagreb Control until the message was understood. MR. Kroese was called to Zagreb in order to give statement as a witness. In his first statement he said that previously horizontal (straight) condensation trails had changed into broken, vertical ones. In his repeated statement he said that he had seen 10 NM long condensation trails behind the TRIDENT aircraft.

According to the statement of witnesses on the ground one aircraft entered a steep dive rolling around. The other aircraft entered a steep dive, pitching occasionally nose upwards. According to the statement of witnesses on the ground, one aircraft started to turn to the left at the height of about 2.000 meters. A substantial part of the aircraft detached during the first turn and descended separately without turning.

The collision occured above Zagreb VOR $45^{O}53'33"$ N, $16^{O}18'38"$ E, in daylight.

The impact location of the DC–9 aircraft was 1 km. eastward from the village Dvorište.

The impact location of the TRIDENT aircraft was 1,5 km. south of the village Gaj near Vrbovec.

The distance between the impact locations was 7 km.

1.2. INJURIES TO PERSONS

a) Trident Three Aircraft

Injuries	Crew	Passengers	Others
Fatal	9	54	–
Serious	--	–	–
Minor/None	–	–	–

b) DC–9 Aircraft

Injuries	Crew	Passengers	Others
Fatal	5	108	–
Serious	–	–	–
Minor/None	–	–	–

c) T o t a l

Injuries	Crew	Passengers	Other
Fatal	14	162	–
Serious	–	–	–
Minor/None	–	–	–

1.3 DAMAGE TO AIRCRAFT

The TRIDENT THREE aircraft, registration marks G–AWZT and the DC–9–32 aircraft, registration marks YU–AJR were completely destroyed in this accident.

1.4 OTHER DAMAGE

a) The TRIDENT aircraft fell on a corn field and damaged an area of approximately 70 x 70 m. Other parts of the aircraft which were scattered over an area of 7 km., caused, in certain places, slight damage to crops. It was not possible to evaluate this damage.

b) The DC–9 aircraft fell in a forest area. The impact and fire damaged the forest vegetation over an area of approximately 70 x 70 m. No other damage on the ground was observed.

1.5 CREW INFORMATION

a) Flight crew members of TRIDENT THREE

Captain TANN DENNIS VICTOR

Born on 21 June 1932.
He joined British Airways on 11 July 1957. He held a licence ALTP 32349 valid until 19 December 1977.

Information on check dates:

– simulator:	20 December 1975
	27 April 1976
– instrument rating:	19 December 1975
– route check: as P1	18 July 1976
– licence medical:	5 July 1976
– survival drills:	31 October 1975

Flying hours:

– total as pilot:	10781 hours
– total British Airways:	8855,6 hours
– total TRIDENT:	399,6 hours
– total last 28 days:	33,0 hours
– total las 3 days:	2,12 hours

Duty time last 7 days:

– Day 1 (04 Sep 76):	Glasgow/Heathrow/Edinburgh/Heathrow
	On duty 0550 hrs.
	Off duty 1417 hrs.
	Flight time 3.14 hrs.
– Day 2 (05 Sep 76)	Off duty day
– Day 3 (06 Sep 76)	Off duty day
– Day 4 (07 Sep 76)	Standby home
	Duty hours 1600–2200 hrs.
– Day 5 (08 Sep 76)	Standby home
	Duty hours 1000–1600 hrs.
– Day 6 (09 Sep 76)	Airport Standby
	On duty 0730 hrs.
	Heathrow/Brussels/Heathrow
	Off duty 1238 hrs.
	Flight time 2.12 hrs.
– Day 7 (10 Sep 76)	Airport Standby
	On duty 0720 hrs.

First Officer, HELM BRIAN EDWARD

Born on 17 May 1947.
He joined British Airways on 24 February 1969. He held a licence ALTP No. 68088 valid until 30 December 1979.

Information on check dates:

– Simulator	02 October 1975
	05 March 1976
– instrument rating:	02 October 1975
– route check: as P2/P3	27 March 1976
– licence medical:	15 July 1976
– survival drills:	09 February 1976

Flying hours:

– total as pilot:	3655 hrs.
– total British Airways:	3414,3 hrs.
– total TRIDENT THREE	1592,5 hrs.
– total last 28 days:	35,6 hrs.
– total last 3 days:	1,55 hrs.

Duty time last 7 days:

– Day 1 (04 Sep 76):	Off duty
– Day 2 (05 Sep 76):	Off duty
– Day 3 (06 Sep 76)	Off duty
– Day 4 (07 Sep 76):	Airport Standby
	On duty 0540 hrs.
	Off duty 1140 hrs.
– Day 5 (08 Sep 76):	Airport Standby Heathrow/Paris/Heathrow
	On duty 0540 hrs.
	Off duty 1124 hrs.
	Flight time 1.55 hrs.
– Day 6 (09 Sep 76):	Standby home
	Duty hours 0955–1555
– Day 7 (10 Sep 76)	Airport Standby
	On duty 0720 hrs.

Acting First Officer FLINT MARTIN JONATHAN

Born on 12 June 1952.
He joined British Airways on 2 April 1973. He held a licence SCPL No. 91376 valid until 24 February 1986.

Information on check dates:

– simulator	30 October 1975
	05 March 1976
– instrument rating:	30 October 1975
– route check: as P2	17 May 1976
as P3	18 May 1976
– licence medical:	25 May 1976
– survival drills:	11 June 1976

Flying hours:

– total as pilot:	1640 hrs.
– with British Airways:	1497,7 hrs.
– total TRIDENT THREE	1444,3 hrs.
– total last 28 days:	32,54 hrs.
– total last 3 days:	Nil

Duty time last 7 days:

– Day 1 (04 Sep 76):	Heathrow/Rome/Heathrow
	On duty 0625 hrs.
	Off duty 1336 hrs.
	Flight time 4.49 hrs.
– Day 2 (05 Sep 76):	Heathrow/Edinburgh/Heathrow
	On duty 0940 hrs.
	Off duty 1415 hrs.
	Flight time 2.14 hrs.
– Day 3 (06 Sep 76):	Off duty
– Day 4 (07 Sep 76):	Off duty
– Day 5 (08 Sep 76):	Leave
– Day 6 (09 Sep 76):	Leave
– Day 7 (10 Sep 76):	Airport Standby
	On duty 0720 hrs.

b) Other crew members of the TRIDENT THREE aircraft

Chief Steward, CROOK DAVID JOHN

Born on 24 December 1942.
He joined British Airways on 29 March 1965.

Chief Steward, O'KEEFE LAWRENCE JOSEPH

Born on 23 April 1946.
He joined British Airways on 13 April 1970.

Chief Stewardess, WHALLEY ANNE PAULINE

Born on 31 August 1944.
She joined British Airways on 7 March 1966.

Stewardess Grade I, GODDARD–CRAWLEY RONA

Born on 22 September 1944.
She joined British Airways on 12 April 1966.

Stewardess Grade II, MUNDAY JENNIFER DIVVERA

Born on 11 February 1946. She joined British Airways on 19 June 1967 and air crew from 26 April 1976.

Stewardess Grade I, PEDERSEN RUTH WEINREICH

Born on 26 April 1950.
She joined British Airways on 28 February 1972.

c) Flight crew members of the DC–9 aircraft

Captain, KRUMPAK (Anton) JOŽE

Born on 11 March 1925 in Rogaška Slatina. He held an airline transport pilot licence No. 103/335 valid until 27 October 1976. He passed his last medical examination on 30 March 1976 and was found fit according to criteria "A" for flying on the DC–9 aircraft.

He had flown on the following types of aircraft:
– DC–6B
– DC–8
– DC–9

He joined Inex Adria Airways in 1962.

He had the last in-flight check on 11 April 1976 and obtained a mark STANDARD.

Flying hours:

– total as pilot:	10.157 hrs.
– on the DC–9 aircraft:	3.250 hrs.
– total last month:	94 hrs.
– total last 3 days:	18 hrs.

Duty time last 7 days:

– Day 1 (04 Sep 76);	Rest at home
– Day 2 (05 Sep 76):	Dubrovnik–Stuttgart–Dubrovnik
	Dubrovnik–Hamburg
– Day 3 (06 Sep 76):	Hamburg–Tivat–Ljubljana
	Ljubljana–Tunis–Ljubljana
– Day 4 (07 Sep 76):	Rest at home

– Day 5 (08 Sep 76): Pula–Dusseldorf–Pula
Pula–Hamburg
– Day 6 (09 Sep 76): Hamburg–Pula–Cologne–Pula–Hamburg
– Day 7 (10 Sep 76): Hamburg–Split to Cologne

Date	Route	Flying hours		Duty time	
		hours	min.	hours	min.
9.09	HAN–PUY–CGN–PUY	6	31	10	45
10.09	HAN–SPU	2	03	3	33

Second pilot, IVANUŠ (Branko) DUŠAN

Born on 15 June 1947 in Ljubljana. He held a professional pilot licence class I No. 357/2493 valid until 16 October 1976. He passed his last medical examination on 30 March 1976 and was found fit according to criteria "A" for flying on the DC–9 aircraft.

He had flown on the following types of aircraft:
– CONVAIR CV–440
– DC–9

Upon the request of Inex Adria Airways he joined the company on 28 June 1976, to fly on temporary basis.

He had the last in-flight check on DC–9 on 30 June 1976 and obtained a mark STANDARD, for co-pilots.

Flying hours:

– total as pilot:	2.951 hrs.
– on the DC–9 aircraft:	1.583 hrs.
– total last month:	84 hrs.
– total last 3 days:	11 hrs.

Duty time last 7 days:

– Day 1 (04 Sep 76):	Dubrovnik–Bristol–Dubrovnik–Ljubljana
– Day 2 (05 Sep 76):	Rest at home
– Day 3 (06 Sep 76):	Rest at home
– Day 4 (07 Sep 76):	Rest at home
– Day 5 (08 Sep 76):	Pula–Dusseldorf–Pula–Hamburg
– Day 6 (09 Sep 76):	Hamburg–Pula–Hamburg
– Day 7 (10 Sep 76):	Hamburg–Split–Split to Cologne

Date	Route	Flying hours		Duty time	
		hours	min.	hours	min.
9.09	HAN–PUY–CGN–PUY	6	31	10	45
10.09	HAM–SPU	2	03	3	33

d) Other crew members of the DC–9 aircraft

Chief Stewardess, OFENTAVŠEK (Vili) LIDIJA

Born on 30 July 1947 in Maribor. She held a licence No. 196/3408 valid until 10 December 1976. Medically fit.

Stewardess, SILA (Franc) MOJCA

Born on 13 April 1953 in Gornja Bitnja. She held a licence No. 1197/6668 valid until 29 January 1977. Medically fit.

Stewardess, ŽAGAR (Vinko) JELKA

Born on 26 March 1952 in Ljubljana. She held a licence No. 950/6050 valid until 5 November 1976. Medically fit.

e) Information about air traffic controllers

DAJČIĆ JULIO – Chief of the Shift

Born on 17 December 1932 in Pula.
He passed the exam for area radar controller on 27 August 1963. He passed his last medical examination in 1971 and was found fit according to criteria "B".

Duty time last 7 days:

– Day 1 (04 Sep 76):	Off duty
– Day 2 (05 Sep 76):	Off duty
– Day 3 (06 Sep 76):	07.00 – 19.00[1)]
– Day 4 (07 Sep 76):	19.00 – 07.00 on 8th September
– Day 5 (08 Sep 76):	Off duty
– Day 6 (09 Sep 76):	Off duty
– Day 7 (10 Sep 76):	07.00 – 11.15

TASIĆ GRADIMIR, Air Traffic Controller

Born on 29 April 1949 in Niš.
He passed the exam for area radar controller on 26 May 1976. He passed his last medical examination in 1971 and was found fit according to criteria "B".

Duty time last 7 days:

– Day 1 (04 Sep 76):	Off duty
– Day 2 (05 Sep 76):	Off duty
– Day 3 (06 Sep 76):	07.00 – 19.00
– Day 4 (07 Sep 76):	Off duty
– Day 5 (08 Sep 76):	07.00 – 19.00
– Day 6 (09 Sep 76):	07.00 – 19.00
– Day 7 (10 Sep 76):	07.00 – 11.15

---

1) Local time

TEPEŠ NENAD, Assistant Air Traffic Controller

Born on 2 September 1943 in Zagreb.
He obtained his licence for terminal radar control in December 1975. He passed his last medical examination on 26 February 1976 and was found fit according to criteria "B".

Duty time last 7 days:

– Day 1 (04 Sep 76):	Off duty
– Day 2 (05 Sep 76):	Off duty
– Day 3 (06 Sep 76):	07.00 – 19.00
– Day 4 (07 Sep 76):	Off duty
– Day 5 (08 Sep 76):	07.00 – 19.00
– Day 6 (09 Sep 76):	Off duty
– Day 7 (10 Sep 76):	07.00 – 11.15

HOEHBERGER MLADEN, Air Traffic Controller

Born on 13 October 1946 in Zagreb.
He obtained his licence for area radar controller on 17 May 1976. He passed his last medical examination in 1971 and was found fit according to criteria "B".

Duty time last 7 days:

– Day 1 (04 Sep 76):	Off duty
– Day 2 (05 Sep 76):	Off duty
– Day 3 (06 Sep 76):	07.00 – 19.00
– Day 4 (07 Sep 76):	Off duty
– Day 5 (08 Sep 76):	07.00 – 19.00
– Day 6 (09 Sep 76):	Off duty
– Day 7 (10 Sep 76):	07.00 – 11.15

ERJAVEC BOJAN, Air Traffic Controller

Born on 15 June 1947 in Beograd.
He obtained his licence for area procedural controller on 8 March 1976. He passed his last medical examination in 1974 and was found fit according to criteria "B". During the seven days prior the accident he was on holiday.

PELIN GRADIMIR, Assistant Air Traffic Controller

Born on 18 April 1948 in Beograd.
He obtained his licence for area radar controller on 26 April 1976. He passed his last medical examination in 1971 and was found fit according to criteria "B".

Duty time last 7 days:

– Day 1 (04 Sep 76):	Off duty
– Day 2 (05 Sep 76):	Off duty

– Day 3 (06 Sep 76):	07.00 – 19.00
– Day 4 (07 Sep 76):	Off duty
– Day 5 (08 Sep 76):	07.00 – 19.00
– Day 6 (09 Sep 76):	Off duty
– Day 7 (10 Sep 76):	07.00 – 11.15

Since 1975, under Federal Civil Aviation Regulations, all Air Traffic Controllers have been required to undergo an annual medical examination. At the date of the accident the re-examination of all controllers had not been completed. However, there is no evidence that medical factors had any bearing on the cause of the accident.

1.6 AIRCRAFT INFORMATION

a) The TRIDENT THREE Aircraft

The aircraft TRIDENT–3 B SERIES 101, registration marks G–AWZT, serial number 2320 has been manufactured by HAWKER SIDDELEY, AVIATION LTD., England.

Date of manufacture: 5th June 1972. Aircraft category: TRANSPORT CATEGORY (PASSENGER).

Owner of the aircraft: British Airways Board, Air Terminal, Buckingham Palace Road, London SW1. W 9SR.

The aircraft had a Certificate of Airworthiness valid until 27 May 1978.

Until the accident the aircraft had flown a total of 8627,44 hours and had performed 6.952 landings.

POWER PLANT DATA

Three Rolls–Royce Spey MK 512–5W turbo-fan engines and one Rolls–Royce RB 162–86 turbo-jet boost engine were installed.

Engine no.	Engine serial no.	Hours of operation from O/HAUL	Total operation	T.B.O.
1	4738	2409.44	7644.31	8236
2	4560	8472.03	12600.50	9612
3	4708	2648.54	8277.35	2750
Boost engine	1205	–	1240.00	1400

All checks, maintenance and replacement were carried out regularly until the accident.

Review of documentation revealed that there were no complaints concerning the operation of aircraft systems which would be relevant to the accident.

According to the load sheet at the last take-off, the aircraft was correctly loaded and the position of the centre of gravity was within the approved limits.

Type of fuel was JP 1A aviation kerosene.

b) The DC–9 Aircraft

The aircraft DC–9–32, registration marks YU–AJR, Registar No. 1073, serial number 47649, manufactured by McDONELL DOUGLAS CORPORATION, USA.

Date of manufacture: 7th March 1976 (According to the Export Certificate No. E 144587). Aircraft category: TRANSPORT CATEGORY (PASSENGER).

Owner of the aircraft: Inex Adria Airways, Ljubljana, Titova 48, Yugoslavia.

The aircraft had a Certificate of Airworthiness No. 1073 valid until 5 March 1977.

Until the accident the aircraft had flown 1.345,22 hours and had performed 990 landings.

POWER PLANT DATA

The engines P8W JT8D–9A were installed.

	S/N	TBO	TT	Rest TBO
Starboard engine	666996	6500	1495,12	5004,48
Port engine	666995	6500	1379,22	5120,38

All checks, maintenance and replacement were carried out regularly until the accident.

Review of documentation revealed that there were no complaints concerning the operation of aircraft systems which would be relevant to the accident.

According to the load sheet it was established that at the last take-off the weight of aircraft and the position of the centre of gravity were within the approved limits.

Type of fuel was JP–1 aviation kerosene.

1.7 INFORMATION ABOUT METEOROLOGICAL CONDITIONS

a) Actual weather situation at "Split" airport on 10 September 1976

0900 hours (GMT)

ground wind 090°/10 Kts.
visibility: over 10 km.
clouds: 4/8 Sc.with the ceiling at 4.300 feet and
4/8 Cs. with the ceiling at 20.000 feet
temperature: 22°C
QNH: 1013 mb

0930 hours (GMT)

ground wind 120°/12 Kts.
visibility: over 10 km.
clouds: 4/8 Cu. and Sc. with the ceiling at 3.300 feet and
5/8 Cs with the ceiling at 20.000 feet
temperature: 22°C
QNH: 1013 mb

b) Actual weather situation at "Zagreb" airport

0900 hours (GMT)

ground wind 230°/8 Kts.
visibility: over 10 km.
clouds: 3/8 Sc. with the ceiling at 4.700 feet
temperature: 19°C
QNH: 1010 mb

0930 hours (GMT)

ground wind 230°/12 Kts.
visibility: over 10 km.
clouds: 2/8 Sc. with the ceiling at 4.700 feet
temperature: 20°C
QNH: 1010 mb

1000 hours (GMT)

ground wind 210°/11 Kts.
vidibility: over 10 km.
clouds: 1/8 Cu. at 4.000 feet and
3/8 Sc with the ceiling at 4.700 feet
temperature: 21°C
QNH: 1009 mb

c) Radiosonde measuring for Zagreb

Measuring at 0001 hours (GMT)

The data for ICAO standard level 300 mb

temperature was: – 43.1°C
upper wind was: 225°/23 Kts.
altitude was: 9340 gpm

The data for ICAO standard level 250 mb

temperature was: – 52.6°C
upper wind was: 230°/27 Kts.
altitude was: 10.550 gpm

The data for ICAO standard level 200 mb

temperature was: – 57.9°C
upper wind was: 230°/27 Kts.
altitude was: 11.970 gpm

Measuring at 1200 hours (GMT)

Level 300 mb

temperature was: – 42.5°C
upper wind was: 220°/41 Kts.
altitude was: 9350 gpm

Level 250 mb

temperature was: –52.7°C
upper wind was: 220°/45 Kts.
altitude was: 10.550 gpm

Level 200 mb

temperature was: – 56.9°C
upper wind was: 250°/51 Kts.
altitude was: 11.960 gpm

Weather in Zagreb area around 33000 feet at the time of collision was reported as fine, with no clouds and good visibility.

The position of the sun at 1015 (GMT) was Azimuth 116°, Altitude 48°.

1.8 GROUND RADIO–NAVIGATION AIDS (OPERATIONAL AND STAND BY)

The NDBs "Zagreb", "Kostajnica" and "Vrlika" as well as "Zagreb" VOR were in operational condition without any failure in operation.

The quoted findings were established on the basis of the following:

- Daily reports on the operation of the aids,
- The results of the control receivers,
- Operational log book,
- No complaints concerning the operation of these aids,
- Measurement lists

On the basis of the review of the operational condition of the radar system (primary and secondary) in the Area Control Centre Zagreb on 10 and 11 September 1976, and particularly of the operational post no. 26 (upper sector), review of documentation and consultations with the employees in the shift, it was established that:

- the entire radar system was in operational condition,
- the targets and data from primary and secondary radar and video maps were clear without disturbances. There were no complaints concerning the operation.

On the basis of the above, it was established that the radar system was fully operational.

The Decision of FCAA No. 561/1 dated 31 January 1974 approved the operational usage of the radar TH–CSF LS–23 and on the basis of Commission report with the following limitations:

- operational usage is approved within the range of 100 NM,
- during separation of aircraft double ICAO standards should be used.

According to NOTAM class IIa 8 dated 15 September 1974, the usage of SSR on a trial basis was approved in Beograd and Zagreb starting on 1 October 1974, with allocation of codes for each sector within the area.

1.9 GROUND–AIR COMMUNICATION (OPERATIONAL AND STAND BY)

Radio-telephone equipment for ground-air communication on the frequency 124,6 MHz (lower sector), 135,8 MHz (middle sector) and 134,45 MHz (upper sector) was in operational condition without any failure.

1.10 INFORMATION ABOUT ZAGREB AIRPORT

The airport and airport services and handling facilities were in operational condition and are not relevant to the accident.

1.11 FLIGHT AND VOICE RECORDERS

Flight and Voice Recorders of both aircraft were identified at the site of the accident and were taken by Zagreb court of inquiry authority.

On 16 September 1976 the transcription of voice recorders from both aircraft was made at JAT Technical Division, Beograd airport, in the presence of the court of inquiry authorities, members of the Commission for investigation the causes to the accident and the advisers to the UK accredited representetive. At the same time, it was decided that the transcription of flight recorder from the DC–9 aircraft would be made at JAT Technical Division and the transcription of the TRIDENT–3 flight recorder to be made in London because there was no possibility with us to do so. On behalf of the Yugoslav Commission two experts were designated to participate at the transcription of the flight recorder in London.

a) The TRIDENT THREE flight recorders

Three flight recorders were installed on this aircraft:

1. DAVAL RECYCLING WIRE RECORDER, Type 1192, Series No. 631

This flight recorder records the flight parameters, aircraft movements and engine parameters for a total of 25 hours.

The recorder consists of reels with flexible wire on which the flight parameters are recorded every second.

The recorder is placed in a strong metal sphere resistant to external shocks. It is located in the tail section of the aircraft and records the following flight parameters:

– time in seconds,
– altitude according to standard pressure,
– recorded instrument airspeed,
– pitch and roll angle,
– normal acceleration,
– turning around longitudinal axes,
– radio altitude,
– movement of flaps,
– movement of rudder,
– magnetic heading,
– autopilot engagement.

Besides the mentioned flight parameters the recorder records many parameters of each engine operation.

During the investigation the flight recorder was found at the site of the accident. The Commission took it to British Airways where it was opened. The wire was broken at one place, but not at the place where the portion of the flight from Klagenfurt to ZAG VOR was recorded.

The flight recorder data were fed into the computer from which the processed numerical and graphic data were obtained.

Every second the recorder recorded all parameters of the flight from tke take-off at Heathrow until the moment of collision.

The collision occured under the following flight conditions:
Altitude: H = 33380 feet

Taking into account the tolerance it comes out that
total altimeter error was .....–420 feet
therefore the recorded altitude was..... 33380 feet
– 420 feet
Corrected altitude..... 32960 feet

The aircraft was operating at 32960 feet – FL 330

Heading

From crossing the Yugoslav–Austrian border, towards ZAG VOR until 2 minutes 50 seconds before the collision, the aircraft was flying on a heading 120^{o} – 122^{o} (The heading for this airway is 120^{o}).

2 minutes 50 seconds before the collision the aircraft changed heading to 115^{o} and for the last 5 seconds to 116^{o} which was maintained until the collision with the DC–9.

Instrument airspeed

During the flight along the airway UB5 the aircraft maintained IAS (instrument airspeed) of 291–295 Kts. which corresponded to TAS (true airspeed) – 479 Kts. or 905 km/h (0.81 Mach).

As the side wind was at an angle of $90–100^{o}$, the ground speed was 489 Kts.

At the time of the accident the autopilot was engaged.

The characteristics of the other parameters suggest that the height lock was also engaged in the autopilot system.

Other parameters were not relevant to the accident.

2. VOICE RECORDER

"Cockpit voice recorder" Fairchild Model A 100, series 3804 (magnetic type) installed on the Trident–3 aircraft, G–AWZT, records the conversation of pilots with the air traffic controllers. Therefore it records all voice communications.

It is located in the fuselage, on the rear right side. It was found at the site of the accident. The tape was not damaged. During the transcription, on 16 September at JAT Technical Division, it was established that theree channels of the voice recorder on the Trident–3 were unintelligible. On the fourth channel only the conversation in the cockpit was recorded. All four channels were affected by noise.

The conversation between the crew members was the following:

First part of the conversation referred to the conditions and prices at the market, afterwards they were talking about the accident to some helicopter and transportation of the injured to hospital. It was also heared that one of the crew was doing a cross word. The moment of collision was not recorded because the cockpit was cut through and the crew suffered fatal injuries.

According to cockpit voice recorder there was no conversation in the Trident aircraft during the last 5 minutes.

The tape of the Trident–3 voice recorder was copied at JAT Technical Division and ACC Beograd, on the standard tape and cassette. It was copied in two copies of which one was given to the UK accredited representative.

The copied tape was transcribed at the UK Accidents Investigation Branch in London and written transcription was made of all conversation and noise which were recorded with the explanations. The UK accredited representative submitted, on 21 October 1976, to the Yugoslav Commission, a copy of the written transcription of tape recordings which constitutes an integral part of the Attachments to this Report. The UK accredited representative gave us a copied tape on which the noise was filtered.

Upon the completion of trial in Zagreb, the UK accredited representative required from our Commission the original tape of the Trident–3 voice recorder in order to establish the reason for which the first three channels were inoperative and did not record anything.

Transcription of original tape made at the UK Accidents Investigation Branch, London, revealed that all four channels recorded the conversation correctly but the device for transcription at JAT Technical Division was out of order.

The U.K. Accredited representative submitted the copied conversation on all four channels and also a recording on paper tape which contained conversation between the crew of the DC–9 aircraft and ATC immediately before the collision.

On the basis of the above, the Yugoslav Commission accepted the correction that all four channels of the Trident–3 voice recorder were in order and that the failure of the device at JAT Technical Division was in question.

The competent U.K. authorities required the return of the original flight and voice recorders and it was done accordingly.

3. Quick Access Data Recorder

The recorder (DAVAL CASSETTE RECTURE 1089) is a cassette recorder designed to be either a part of the AIDS system or to operate independently as a Quick Access Data Recorder. A Davall cassette, type 1223 with a tape 1/2 inch wide and minimum length of 325 feet is used. It is located in the cockpit. It was not found at the site of the accident, therefore it was not used for analysis.

b) The DC–9 aircraft recorders

The following recorders were installed in the aircraft:

1. FLIGHT RECORDER

A flight recorder SUNDSTRAND Model No. FA–542, series no. 5078 was installed on the DC–9 aircraft, YU–AJR. The recorder was calibrated on 10 December 1974.

The recorder records five parameters on metal tape located in a very resistant steel cassette. It records the following parameters:

– altitude according to standard pressure,
– instrument airspeed,
– magnetic heading,
– normal acceleration,
– time of microphone switching on[1)]

The recorder is located in the tail cone of the fuselage. Before the begining of the flight a pilot records a flight number and the date on the tape by means of a mechanism in the cockpit.

Re-winding of the tape is performed with a speed of 6 inches per hour and its capability is 400 hours on each side of the tape, i.e. 800 hours in total. After that the tape has to be replaced.

The recorder was found at the site of the accident. The decoding was performed at JAT Technical Centre, the flight parameters were read and the diagrams made.

Every second the recorder recorded the flight parameters from the take-off at Split airport.

The collision occured under the following conditions:

Altitude: H = 32445 feet

Calibration tolerance for this height was extracted from TABLE 701 (attached) – ALTITUDE RECORD CALIBRATION DATA Sensor Part No. 100435, which shows at 33000 feet that calibration correction was + 450 feet and a readout tolerance was + 50–100 feet.

Recorded altitude	32445 ft.
Calibration correction	+450 ft.
Readout tolerance	+50–100 ft.
Corrected altitude	32900–33050 ft.

See Attachment – Flight profile for both aircraft.

---

1) This parameter revealed the information that the last switching on of the microphone and the message to the control were 22 seconds before the end of the flight parameters recording

Heading

From Split VOR the aircraft maintained a heading of 359 to +005°. At the moment when it overflew NDB KOS, the heading was reduced to 353° and this was maintained until the collision.

Instrument airspeed

As the aircraft was mostly climbing it maintained an instrument airspeed of 261 – 283 Kts. In the transition to level flight, 18,6 minutes after the take-off indicated aispeed was 316,6 Kts.

At the moment of collision, in level flight, indicated aispeed was 261 Kts., or true airspeed was 430 Kts., and the ground speed, due to tail and side wind was 465 Kts or 861 km/h.

2. Voice recorder

A voice recorder, installed on the DC–9 aircraft YU–AJR, records the conversation between the pilots and the conversation of the crew with the air traffic control. Therefore, it records all voice communications.

It is located in the rear hold in front of the cargo compartment door and it was found in the wreckage. The tape was not damaged and it was heared and transcribed.

On the basis of the transcription of tape recordings of the voice recorder, the following was found out:

1. The recordings of the conversation in the DC–9 aircraft cockpit were found on the second channel. The other channels contained the recordings of the conversation with the air traffic control.

2. Reviewing the recordings on all channels it was established that the voice recorder was not recording constantly but with several interruptions. This could be concluded on the basis of the following:

– there was a report about the position of an unidentified aircraft with the data about being over an unidentified fix at 08.46 min., and an estimated time over the next fix at 09.08 minutes. This was heared on the tape 1 minute 15 seconds before the accident;

– the conversation between the crew of JP 550 and JP 548 was recorded. It was held on the apron of Split airport about 09.40 min., which is 35 minutes before the accident;

– a message from Split Aerodrome Control was recorded. It referred to the take-off of JP 550 which was at 09.48 min., with the instruction to report passing Split VOR at FL 120. This message was transmitted about 25 minutes before the accident. It is believed that soon after this message the voice recorder ceased recording and restarted at the moment of the accident;

– on the basis of listening to all channels it was established that the tape was not moving at constant speed at the time of recording. This was established on the basis of distortion of the recorded tones;

– it was established that the tape of the voice recorder ceased moving on several occasions in total duration of 1 hour and 25 minutes.

Approximately 20 minutes before the accident no conversation was recorded in connection with the critical phase of the flight, due to the tape stopping. At the moment of the crash the voice recorder reactivated and recorded for 25 seconds the conversation and sounds in the cockpit of the DC–9 aircraft. The sounds which were recognized in those 25 seconds of recording are shown in the Attachment.

1.12 INFORMATION ABOUT THE CONDITION AT THE SITE OF THE ACCIDENT

The collision between the aircraft, as seen from the air and from the ground is described in item 1.1.

The site of impact may be divided into the following zones:

- The site on which the TRIDENT THREE fell and the immediate surroundings of this location;
- The site on which the DC–9 fell and the immediate surroundings of this location;
- The area between the two impact zones;
- The area upon which light material was blown away by wind.

a) The site on which the TRIDENT THREE fell

The aircraft struck the ground in a tail down, starboard wing low attitude. There was no apparent forward movement of the aircraft. Due to severe vertical impact and slight drift to the left, the aircraft was completely deformed but the outlines were visible. The starboard wing was deformed more than the port wing. Tail surfaces and engines were on the ground and were deformed and broken (rear centre of gravity during the impact).

All bodies within the aircraft were displaced to the right side of the fuselage. A part of the tail surface was found 30 m to the east of the aircraft, probably it broke during impact and due to inertia it slid laterally from the aircraft. At the site of the main impact was the fuselage aft of frame 33 up to the tail surfaces, both wings and the engines.

Some 600 m. north-west from this site was the cockpit, cut horizontally, together with the fuselage structure up to frame 18. The cockpit was cut at the junstion of the pilot's windshield and the upper cowling of the aircraft nose. Two crew members were found to the right of the cockpit and one crew member was found to the left in the cockpit.

This part of the cockpit and fuselage fell vertically in the normal level attitude without any forward movement.

Scratches were visible on the cut part of the cockpit, these ran from the right side at a small angle in relation to the horizontal centreline.

The fuselage cowling was bent from the right to the inner side and from the left to the outer side.

Both control columns were cut. The upper part of one column (about 20 cm.) was found immediately to the cockpit.

The instruments, controls and switches were broken or deformed.

The indications of some instruments in the cockpit were as follows:

– airspeed indicator ..... 305 Kts.
– fuel contents indicator..... 2020 kg.
(there were five fuel tanks)
– Co-pilot's flight compass showed left of radial
– VOR showed FROM
– autopilot height selector was deformed and showed ..... 3 $\frac{3}{2}$ 0
– navigation aid no. 1 showed..... 113.1 MHz
– altimeter ..... 33050 feet

It was established at the site of the accident that a part of the fuselage from the 18th to 33rd frame was missing.

b) The site on which the DC–9 fell

The aircraft fell on the ground touching it with the right wing and in a flat inverted position. At the site of the accident the aircraft was without the tail surfaces and the tail cone and also without a part of the left wing to a length of 5 meters.

The left engine was found with substantial damages to the compressor blades.

After the impact there was no forward movement of the aircraft.

After the impact the aircraft burned out. Tail surfaces and minor parts of the DC–9 were found in the area 2,5 km around the aircraft. A part of the left wing was not found. The cockpit and the installations burned out and no data could be seen on the instruments.

The bodies within the aircraft were rather disintegrated and burned.

c) Area between the two impact zones

Many small and large parts of the aircraft and heavier passenger baggage were found in the area between the villages Krkač–Graberanec to the north and Pirakovec–Vrbovec to the south. Several bodies and parts of passenger bodies were also found (cf. Attachment No. 3). With the assistance of the British representatives – experts, the pieces of wreckage which were found were identified as the parts of the TRIDENT THREE aircraft and these were mainly the parts of the disintegrated fuselage from 18th do 33rd frame and the top of the cockpit. Some major parts were taken away for the purpose of reconstruction of the air collision.

d) The area in which light material was scattered

The area extended from north-east of Vrbovec to 8 km., north-east from Križevci. The direction of this area is north-east (40^{o}) to a distance of 32 km (Tiny pieces of paper were blown away by wind to a distance of 90 km). This area is marked on the chart at a scale 1 : 50.000. Small and light items such as parts of clothes, documents, magazines, journals, books and other pieces of paper were found in this area.

1.13 MEDICAL AND PATHOLOGICAL FINDINGS

a) Crew of the TRIDENT THREE aircraft

On 12 October 1976 the Department of Aviation and Forensic Pathology, Institute of Pathology and Tropical Medicine, Royal Air Force, Halton, submitted a pathology report concerning the flight crew members of this aircraft.

The authopsy revealed that all three crew members were without complete bodies, therefore the investigation was limitted to the existing parts of bodies.

The cause of death of all crew members was severe injuries obtained in the aircraft collision.

No other causes of death were found and the state of health during the flight was not impaired by exsessive usage of medicines, drugs, narcotics, etc.

b) Crew of the DC–9 aircraft

The Institute of Forensic Medicine and Criminology, Medical University, Zagreb, has submitted the findings of the DC–9 aircraft crew members.

Severe injuries which caused death were found on the body of Captain Krumpak Jože.

On the basis of toxicological analysis it was established that liver tissue contained small quantities of largactile, in therapeutic values. It was established that the medicine was taken shortly before death.

It was also established that at the moment of death, Captain Krumpak was healthy.

Due to disintegration and late identification it was impossible to make any analysis on the body of Co-pilot Ivanuš.

1.14 FIRE

After impact, the DC–9 aircraft caught fire. Eight minutes after the impact a fire brigade "PRESKA" consisting of 12 voluntary firemen, vehicles and equipment came to the site of the accident. They immediately started extinguishing the fire with water.

At 10.36 (GMT) a fire brigade in Zagreb was informed about the accident and fire. At 11.06 they were at the site on which the DC–9 fell and at 11.07 started extinguishing the fire.

Three different types of vehicles were used.

After the impact, the TRIDENT THREE aircraft did not catch fire. Smoke emerged from some parts of the power plant, but it was extinguished soon. On this occasion the fire brigade used one appliance for technical intervention, one mechanism with dry chemicals and one auto crane. At the site on which the TRIDENT THREE fell two hoses with dry chemicals were placed for the purpose of security, one hose for slow foam and one hose for water mist.

In this phase of fire extinguishing there vere 21 firemen and later on the number increased to 31 firemen and rescuers.

The fire on the DC–9 aircraft was extinguished around 11.15 hours.

Both sites on which the aircraft fell were secured by fire brigades who kept guard.

The fire brigade from Zagreb used the following technical appliances:

- fire vehicle "VM 1300"
- fire vehicle "MAGIRUS"
- water tanks "FAP" with 8.000 1. of water
- fire vehicle "MAGIRUS" for fire extinguishing with foam
- autocranes Mersedes of 10 tonnes
- fire vehicle with dry powder "TOTAL" – 2 x 750 kg.
- two vehicles "MAGIRUS" equipped with tools for cutting, braking, lifting and lighting including one generator of 70 kW

1.15 SEARCH, RESCUE AND EVACUATION

Rescue and evacuation of passengers and crew members started immediately after the collision. Approximately 1.200 persons, medical teams, police, soldiers, firemen and local people took part in this action.

No one survived the collision, therefore medical teams could not render assistance though they reached the site of the accident in the shortest possible time.

Searching for and evacuation of dead passengers and crew members from the TRIDENT lasted two days and from the DC–9 lasted three days.

After the search of the terrain, the position of bodies, parts of aircraft, passengers baggage were plotted on a chart (attached).

The search of the terrain was difficult due to the large area (32 x 10 km), wet terrain after rain, forest vegetation and crops. Regardless of the difficulties the entire area was searched in 4 days.

1.16 TEST AND RECONSTRUCTION

Using the remaining parts of the aircraft a reconstruction was made for the purpose of establishing the position of the aircraft immidiately before the accident and their movement and penetration of the DC–9 wing into the cockpit of the TRIDENT aircraft as well as disintegration after the collision.

The following parts of the aircraft were used for the reconstruction:

TRIDENT THREE

- lower part of the cockpit
- upper part of the cockpit
- radar antenna radome
- forward right service door with frames
- right, lateral part of fuselage skin from service door to frame 23
- partition wall between cockpit and passenger cabin and a folding seat

DC–9

- remaining left wing

The mentioned parts of the TRIDENT THREE were collected and brought to Zagreb ariport where they were put together so that the approximate shape of the forward part of the fuselage could be reconstructed (Attachment No. 16).

Upon the reconstruction of the remaining parts of the TRIDENT THREE and the DC–9 aircraft, the following conclusions were reached:

– With the end of its left wing in the length of approximately 5 meters, the DC–9 struck the base of the forward windows on the TRIDENT THREE cockpit. At the moment of the crash the DC–9 was in a horizontal position. During further movement the wing was breaking through the fuselage of the TRIDENT THREE at the angle of collision. A part of the right fuselage skin was bent inwards while a part of the left fuselage skin was bent outwards.

Due to decompression a forward part of the TRIDENT THREE fuselage disintegrated to the frame 33. An unidentified part of the disintegrated forward part of the fuselage of the TRIDENT THREE struck the rudder of the TRIDENT THREE which disintegrated and fell separately on the ground. The parts of the TRIDENT THREE aircraft from the frame 33 to tail surfaces feel to the ground as an integral part. Due to the weight of the engines the aircraft struck the ground first with the aft part and after the final impact the aircraft slid 4–5 meters to the left and stopped. There was no forward movement.

During penetration of the DC–9 left wing in the length of 5 meters through the fuselage of the TRIDENT TRHEE, the wing was completely cut. Unidentified parts of the DC–9 wing or a part of the forward TRIDENT THREE fuselage reached the left engine of the DC–9 and damaged it.

Due to rotation forces, the broken compressor blades on the left engine of the DC–9 fell out of their hosing striking the left side of the stabilizer and rudder and a lower left side of the elevator, damaging their skin.

After the collision the tail surfaces and cone portion of the DC–9 fuselage broke and disintegrated probably due to the aerodynamic overloading of the tail surfaces or because the vertical surfaces were damaged by secondary impact of the disintegrated parts of the aircraft.

The DC–9 continued falling without tail surfaces and the cone portion of the fuselage, together with the aft staircase. The aircraft struck the ground in a starboard wing low attitude and stopped in an inverted position, thus completely damaging the aircraft structure. Other disintegrated parts of the aircraft were scattered at the distance of 2.5 km.

1.17 INFORMATION ON AIR TRAFFIC CONTROL OPERATION

1. Operation of the JP 550 aircraft within the Lower Sector East of the Zagreb Area Control Centre (frequency 124.6 MHz) which extends from 300 m above ground to FL 250.

Before departing from Split for Cologne the crew of the aircraft JP 550 filed a flight plan in the Flight Information Office requesting FL 310. In the coordination between the Approach Control in Split and the Lower Sector of Zagreb ACC it was agreed that after take-off the aircraft could climb above Split VOR to FL 120 and then set course to NDB Kostajnica climbing to FL 180.

At 09.54'49" the aircraft JP 550 established its first contact with the Lower Sector of Zagreb ACC, while it was passing FL 130 and continuing to climb to FL 180 towards NDB Kostajnica. The Lower Sector controler cleared JP 550 to climb to FL 240 and the crew of JP 550 acknowledged the clearance.

At 09.55'50" JP 550 obtained a clearance to climb to FL 260 and to report passing FL 220 and FL 240. The clearance was issued with the approval of the Middle Sector.

JP 550 was not given clearance for a flight level higher than FL 260 within the Middle Sector because the higher flight levels were occupied: FL 280 by JP 548 which took-off from Split to Nurnberg at 09.42'; FL 310 by OA 187 operating from Athens to Vienna and estimating overhead ZAG VOR at 10.11 hours.

After passing LF 220, there being no conflict traffic between FL 230 and FL 250, the Lower Sector East transferred JP 550 to the Middle Sector frequency 135.8 MHz.

The transfer of JP 550 from the Lower East to the Middle Sector was carried out as follows:

10.02'44"	JP 550:	Zagreb, Adria 550 crossing 220.
	Zagreb:	Zagreb 135.8 Good day.

The coordination and transfer of information between the Lower and Middle Sector was carried out in time on the basis of agreement and transfer of a strip with flight data.

In accordance with Zagreb ACC regulations, flight progress strips should be prepared in advance for all sectors through which the aircraft passes. However, for the flight JP 550, a flight progress strip was not prepared for the Middle Sector. But, this did not affect flight safety within the Middle Sector because the coordination, transfer of information and communications were timely made at the moment of crossing FL 220, i.e. while the aircraft was in the airspace of the Lower Sector East.

2. Operation of JP 550 within the Middle Sector (frequency 135.8 MHz) which extends from FL 250 to FL 310 within Zagreb ACC.

At 10.03'21" JP 550 established a radio contact with the Middle Sector and reported passing FL 225 climbing to FL 260.

The Middle Sector controller instructed JP 550 to select mode/Code A2506 on its transponder and confirmed the clearance to climb to FL 260. Then JP 550 was given instructions to fly towards Kostajnica, Zagreb and Graz.

At 10.05'57" JP 550 reached FL 260 awaiting clearance to climb to FL 310, as had been indicated in the flight plan before take-off. As the controller know that the flight levels 280 and 310 were occupied, he apologized to the crew of JP 550 and asked whether they culd climb to FL 350. The crew answered affirmatively and "with pleasure".

For 1 minute 48 seconds JP 550 was retained in a horizontal flight at FL 260, while, in the meantime the coordination was carried out between the Middle and Upper Sector for climbing to FL 350.

According to the controllers' statement the coordination was effected in the following way:

The Middle Sector controller stated that he signalled by hand to the Upper Sector controller that he wished to talk to him. The Upper Sector controller signalled also by hand that he was busy. Therefore, the Middle Sector Assistant-Controller, who held a radar licence, moved across to the Upper Sector controller who was sitting to his right, at the distance of about 50 cm., to coordinate the climbing. He fingered the target of JP 550 to the Upper Sector controller at his radar display, requesting a clearance for climbing. According to his statement, the Upper Sector controller cleared JP 550 to climb to FL 350.

The Upper Sector controller stated that he only remembers that the Middle Sector assistant-controller showed him some aircraft in vicinity of Kostajnica.

Before giving clearance to JP 550 to climb to FL 350 the Middle Sector assistant-controller was obliged to prepare the appropriate flight progress strip for the Upper Sector. The strip was not prepared in advance because in its filed flight plan the aircraft did not anticipate flying in the Upper Sector.

The statements of the controllers who worked in that shift and the transcripts of the telephone conversation confirm that at that time, the Upper Sector controller was working alone.

At 10.07'40" the Middle Sector controller issued the clearance to JP 550 to climb to FL 350. Shortly afterwards, the assistant controller in this sector informed Vienna ACC by telephone that JP 550 would enter Austrian territory at FL 350.

At 10.09'18" the Middle Sector controller, on the basis of radar monitoring, informed the crew of JP 550 that they were approaching Kostajnica. He instructed the crew to report passing FL 290 and then 310 and the crew acted accordingly.

It was established that the Middle Sector controller who was in radio contact with JP 550 held a licence of area procedural controller while his assistant controller held a licence of area radar controller.

Those two controllers skillfully carried out all radar operations (monitoring, identification, control, separation and transfer of radar identity).

At 10.12'06" when passing FL 310, the crew of JP 550 was instructed to SQUAWK STANDBY temporarily and to change frequency to 134.45 MHz for operation with the Upper Sector.

The crew of JP 550 maintained a radio communication with the Middle Sector until 10.12'12".

Temporary SQUAWK STANDBY deleated from the radar display in this sector the code and altitude of the aircraft while only the indication of his position remained.

Thus, the presentation of the aircraft's target on the Upper Sector display was not changed because until the switching off the aircraft was flying on the altitudes monitored by the Middle Sector.

Each sector in the Area Control is allocated a clearly defined, numerically limitted group of secondary radar codes, which is used for the purpose of easier identification and control of aircraft within a sector.

Therefore, the Middle Sector has at its disposal the codes from A (Alpha) 2500 to A2577 and the Upper Sector from A2300 to A2377.

As the aircraft JP 550 was transmitting the code from the Middle Sector group (A2506) and because during the coordination the Upper Sector did not require transmittion of any code from its group, the Middle Sector controller, in order to release his code during the transfer, required the aircraft to "SQUAWK STANDBY".

The application of "SQUAWK STANDBY" procedure during the transition of an aircraft from one sector to another is not separately regulated either by national or international regulations.

3. Operation of JP 550 and BE 476 with the Upper Sector on the frequency 134.45 MHz within Zagreb Area which extends from FL 310 upwards with no limit.

a) The Upper Sector controller was in radio contact with the TRIDENT THREE aircraft BE 476 which was flying from London to Istanbul. Radio contact was established at 10.04'12" as follows:

BE 476: Zagreb, Bealine 476, Good afternoon.
Zagreb: Bealine 476, Good afternoon, go ahead.
BE 476: 476 Klagenfurt at 02, 330 estimating Zagreb at 14.

The air traffic controller acknowledged this information and required the aircraft to report passing Zagreb VOR, to maintain FL 330 and to select the transponder of the Secondary Radar to mode/code Alpha 2312. The crew of BE 476 did so and acknowledged that code A 2312 was being selected.

10.04'19"	Zagreb:	Bealine 476, Roger, call me passing Zagreb, flight level 330, SQUAWK Alpha 2312.
10.04'38"	BE 476:	2312 coming.

It is believed that on the basis of SQUAWK Alpha 2312 the aircraft BE 476 was identified and the Upper Sector controller saw it on his radar display. Alongside the wtarget of the aircraft the controller should also have seen the selected code and its flight level.

The Upper Sector controller has stated that the altitude readout for BE 476 as displayed on his radar was FL 332 or FL 335. He also stated that the Radar was unreliable and that he therefore decided not to use it.

On that day there had been no reports at the Zagreb Area Control Centre of any malfunction of the radar or height encoding facility and these facilities were normally used before the accident and also when the equipment was subsequently checked after the accident.

The data from Munich and Vienna referring to the operation of the flight BE 476 above those areas showed that the altitude readout was 330, coincidental with the pilot's in flight report.

Air Traffic Control Instructions of the Federal Civil Aviation Administration require the verification of transponder altitudes which vary more than ± 300 feet from the aircraft reported level.

The Upper Sector controller stated that he did not report the discrepancy to the aircraft because he thought it unimportant.

b) At 10.12'12" the aircraft JP 550 was instructed to change to the Upper Sector frequency and immediately before that or at that time, the Upper Sector was given a flight progress strip which was previously used in the Middle Sector.

From the moment this instruction was given until the first contact of JP 550 with the Upper Sector on the frequency 134.45 MHz, 1 minute 52 seconds passed. This could be seen from the transcript of ATC tape recordings. During this time the Upper Sector frequency was continuously occupied by transmissions with the following overflying aircraft: AY 1673, LH 310, OA 172 and BE 932.

Before it had established a radio contact with the Upper Sector, JP 550 was climbing to FL 350 in accordance with the clearance issued by the Middle Sector. Radio contact was established as follows.

10.14'04"	JP 550:	Good morning Zagreb, Adria 550.
10.14'07"	Zagreb:	Adria 550, Zagreb, Good morning, go ahead.
10.14'10"	JP 550:	325 crossing, Zagreb at 14.
10.14'14"	Zagreb:	What is your present level?
10.14'17"	JP 550:	327

The controller realised that a critical situation existed after he had received information from JP 550 that it was passing flight level 327, because he knew that BE 476 at FL 330 was flying in the opposite direction towards Zagreb VOR.

On the Upper Sector radar display the aircraft JP 550 was visible as a circle with a dash (ϴ) without indications of code and altitude.

Then the controller issued JP 550 the following instruction in the Serbocroatian language.[1)]

10.14'22"	Zagreb:	... e ... maintain now on that level and report passing Zagreb.
10.14'27"	JP 550:	What level?
10.14'29"	Zagreb:	At which you are now climbing because ... e ... you have an aircraft in front of you at IS (unreadable) 335 from left to right.
10.14'38"	JP 550:	OK maintain precisely 330.

At, or shortly before 1000 hours, the assistant Upper Sector controller had rotated his duty position because he became the sector radar controller. At the same time a relief assistant controller should have arrived for duty.

It has been established that the Upper Sector assistant controller was absent from his duty position between the hours 10.05' and 10.10' and probably until about 10.13'.

As a result of his absence the sector radar controller had to perform the function of the controller and of the assistant controller as well.

The total number of aircraft within the Upper Sector was 11, requiring numerous RTF transmissions and associated telephone calls (See Attachment 17).

The Chief of the Shift stated that he was at his post throughout the period from 1000 hours to the moment of the collision and that he was unaware of the absence of the Upper Sector assistant controller from his duty position.

However, the Upper Sector controller who had been relieved at 1000 hours or shortly after stated that he informed the Chief of the Shift of the absence of the Upper Sector assistant controller.

The Air Traffic Control recived the first information about the collision at 10.18' from the crew of LH 360 flying from Frankfurt to Belgrade at FL 290 about 15 NM behind BE 476. The information was given through the Middle Sector controller who was in regular radio contact with the crew.

---

1) Use of any other language except English in the Air Traffic Control phraseology is contrary to the DGCA Order No. 04–2192 dated August 22, 1976.

1.18 INFORMATION ON THE DC–9 CLIMB PERFORMANCE

During climb the DC–9 aircraft uses four climb regimes:

1. High speed climb..... 320 kts./0.74 Mach
   (this speed is used for short flights)

2. Long range climb..... 290 kts./0.72 Mach
   (it is used when fuel consumption is factor no. 1 long flights)

3. Maximum rate of climb..... 255 kts.
   (it is used when it is desired to achieve the highest altitude in a specific climb time and most often upon the request of ATC)

4. Single engine climb – maximum gradient .....GW[1)]/1000 Lb + 100 kts
   (it is used when one engine fails and for overjumping of obstacles after take-off)

The flight recorder data showed that the DC–9 aircraft applied the Long range climb (0.72 Mach).

Using this regime of climb the crew of the DC–9 aircraft complied with the policy of its company in respect of economy and exploitation of the aircraft in flight. The Air Traffic Control did not require a special climb regime.

---

1) Gross weight – total weight in thousands librae

1.19 IN FLIGHT LOOK OUT AND LISTENING TO ATC FREQUENCY

1.19.1 Duty of the crew to look out during the flight according to the JAT Flight Operation Manual[1] (The crew of Inex Adria Airways used JAT FOM)

FOM 3.1, page 1, item 102:

"When weather conditions make this possible it is the duty of the crew to keep a sharp look-out during all stages of a flight, as the increased traffic and the higher speeds have also increased the near collision incidents.

In the vicinity of an aerodrome, during descent and climb out to/from an aerodrome and in areas where traffic is dense, crew members shall avoid paper work, map reading, etc.

Observe that when flying in VMC on an IFR flight plan it is the same direct responsibility of the PIC to avoid collision with other aircraft as when flying on a VFR flight plan. The value of information given by ATC is great but may be doubtful in so far as this information only includes known traffic. Such information may temporarily sharpen the look-out at specified times or altitudes and it might be reduced thereafter in the belief that other traffic does not exist. However, information about traffic within the "blind angles" (such as aircraft on approximately the same heading) is always valuable.

Thus, during VMC, a continuous look-out is an absolute necessity. It is the responsibility of PIC to assign a co-pilot for this look-out duty, and to ensure that all other duties, such as strict adherence to ATC clearance (check of navigation instruments), are still properly performed".

1.19.2 Duty of the crew to look out during the flight, according to the extract from British Airways Flight Operation Manual:

"3.2.1 – Maintenance of Any duties which have been laid down for pilots to carry out on board the aircraft in flight should not prevent them from the vital responsibility of maintaining a proper lookout when in VMC conditions".

1.19.3 Weather conditions, visibility, azimuth angle of the sun and inter position of the aircraft enabled the crew of both aircraft to lookout from the cockpit (the DC–9 crew had somewhat more favourable conditions). Crossing of very busy intersection of the airways, as it was the case above Zagreb, required intensified carrying out of this duty.

1.19.4 Duty of the crew to keep a listening watch on ATC frequency, contained in Annex 2 to the Chicago Convention and Flight Operation Manual:

---

1) Similar provisions are contained in the Manuals of the airlines in the following countries: Switzerland, Federal Republic of Germany, Holland, Sweden, Norway and Denmark.

Annex 2, item 3.6.5.1: "An aircraft operated as a controlled flight shall maintain continous listening watch on the appropriate radio-frequency with the appropriate air traffic control unit"....

JAT FOM 3.1, page 14, item 156 regulates the way of communication an listening to the appropriate frequency of the ATC authority.

Similar provisions on active listening are contained in other FOMs and they are prescribed on the basis of Annex 2.

1.19.5 Radio equipment on either aircraft and with the competent ATC authority was in operational condition and enabled undisturbed and continuous work. The crew of JP 550 did not report to the Upper Secotr for 1 min. 52 sec. after its last transmission with the Middle Sector of Zagreb ACC. The crew of BE 476 did not hear the message of the DC–9 reported to the ATC, informing that they were overflying at the approximately same level, same fix and at the same time as BE 476 estimated. According to consequences these omissions were identical with disregarded duty to keep a constant listening on ATC frequency.

1.20 INVESTIGATION THAT WAS CARRIED OUT

1.20.1 Aircraft path according to altitude – Sketch I

On the basis of data obtained from:

- flight recorders from the DC–9 and Trident Trhee aircraft,
- voice recorder from the Trident Three cockpit
- reports of corrected altitudes recorded on the Trident Three flight recorder

and on the basis of calculated flight path of the DC–9 and Trident Three, 32 seconds prior the collision, it could be concluded that for several last seconds the aircraft were flying at the same level or that the DC–9 was even descending slightly towards the Trident Three.

It is supposed that the crew of the DC–9 discontinued climbing by the means of autopilot at FL 330 and afterwards reported to ATC. On the basis of calculation the discontinued climbing of the DC–9 was probably effected 10–16 seconds before the collision. It is known that upon pushing control column forward the aircraft continues for some time to climb above that altitude, due to inertia, and afterwards, in slight descent, it returns to the cleared altitude. The traces of the struck of the DC–9 wing into the fuselage of the Trident Three confirmed a possibility that before the collision the DC–9 aircraft was in slight descent.

The calculation revealed that the DC–9 reached maximum altitude 6 seconds before the collision and that at that moment it was higher than Trident Three for 191 feet. This information partly coincides with the information from the DC–9 flight recorder.

Analysing the flight path 16 seconds before the collision it could be considered that the altitude of the DC–9 aircraft was approximately the same as the altitude of the Trident Three aircraft. Deviations were miscelenious. On the basis of the fact that the Trident Three was forming condensation trails on that flight level (accoridng to the statement of Lufthansa pilot), a logical supposition is that the DC–9 aircraft was forming a visible trail.

1.20.2 Horizontal flight path in relation to the position of sun Sketch II

On the basis of calculation and schematic position of aircraft in a horizontal plane 32 seconds before the collision, the data shows that the crew of the Trident Three aircraft could have seen the DC-9 at the angle of $28^{o}30'$ which remained constant until the collision. The same refers to the crew of the DC–9 aircraft only in this case the angle of vision was $29^{o}30'$.

It comes out that the position of aircraft projection on the windshield was constant and that it slightly changed vertically. During the approach only the aircraft outlines increased. The crew of either aircraft could have sighted each other. Sighting would have caused any reaction by the crews including the procedure for avoidance of collision.

The Sketch 2 depicts the aircraft position in a vertical plane. The Sketch and calculation show that during the last seconds the aircraft were at the same altitude i.e. that common angles around the horizontal axes deviated for approximately 1^{o} irrelevant to possible mutual sighting.

The Sketch 2 also depicts the azimuth angle of the sun which, at that time was 166^{o}. The horizontal projection shows that the Trident Three aircraft was sunlit on the fuselage right side which was visible to the crew of the DC-9. The crew of Trident Three could see the left side of the DC–9 which was in shade. It could be concluded, on the bassis of the above, that the crew of the DC–9 was in somewhat more favourable conditions to see the Trident Three aircraft. The vertical projection of both aircraft shows the sun angle in relation to horizon which was 48^{o}. The Commission did not have information on the visual angles from the Trident Three cockpit but it is supposed that the sun position, due to direct effect, did not prevent the crew of Trident Three to lookout.

1.20.3 View from the DC–9 aircraft – Sketches 3 4

A possible mutual sighting was practically confirmed by taking photos form the DC–9 aircraft.

A DC–9 was placed on the apron of Beograd airport. Its position in relation to the runway i.e. to the touchdown during landing, was the same as the position of either aircraft at 1,76 seconds before the collision.

When on landing the aircraft was in correct angle position in relation to the DC–9 which was on the runway, simultaneous photographing was made from both pilots seats.

The runway centreline represented, in this case, the flight path of the Trident Three aircraft and the photo cameras were placed in the position of pilots eyes.

Thus obtained photo showed the position of the DC–9 aircraft which corresponded approximately to the position of the Trident Three aircraft.

The photo was enlarged in approximate scale 1 : 1.

A smaller aircraft added to the photo represents the approximate proportion of the Trident Three aircraft at about 6 seconds before the collision.

The Sketch 4 shows the approximate position of the Trident Three aircraft as it could have been viewed by the crew of the DC–9, from the left and right seat.

In the same way the crew of the Trident Three aircraft could have seen the position of the DC–9 aircraft.

2. ANALYSIS

2.1 Analysis of the crews operation and other factors relevant to the accident

a) The TRIDENT TRHEE aircraft

The aircraft operated on its scheduled flight BE–476 and the flight operated via West Europe and a portion of the airway above Yugoslavia.

At 10.02' (GMT) it passed Klagenfurt (Austria), at 10.04' reported to Zagreb Area Control Centre at FL 330 estimating Zagreb VOR at 10.14'. Zagreb ACC cleared BE 476 to fly at FL 330 on the airway UB5.

According to Flight Operations Manual of British Airways it is a duty of the crew to lookout even though a flight is being made with IFR plan in VMC (when visibility is good). In the region of collision the weather was fine with great visibility and there was nothing to prevent the crew of TRIDENT THREE to carry out its lookout duty.

At high altitudes, when the aircraft fly under certain angle and particularly when they produce condensation trails, it is possible to sight another aircraft. In this case there are statements of witnesses that the TRIDENT THREE (statement of LUFTHANSA pilot) was forming the condensation trails in the length of at least 10 NM. Such trails were also formed by the DC–9 aircraft (statement of witnesses on the ground) and the fact that immediately before the collision the DC–9 operated, for a while, in the same conditions as TRIDENT THREE). It is evident from the cockpit voice recorder of the British aircraft that the possibility for lookout existed as the conversation between the crew members was recorded after they had seen a Turkish Airlines aircraft passing in the opposite direction 2.000 feet above the British aircraft. A possibility of catching sight of each other was confirmed by the fact that the crew of LUFTHANSA aircraft, as well as the persons on the ground, saw the collision.

Accoring to the provisions of Annex 2 and Flight Operation Manual it is a continous duty of the crew to keep a listening watch on the ATC frequency for the purpose of recognition of possible conflict situations during the flight.

During the transcription of VHF frequency and CVR tape it was established that the crew of BE 476 may have heared JP 550 in vicinity of ZAG VOR before the collision, at the moment when the crew of JP 550 reported, in the English language, its flight level in climb (325) and ZAG VOR at 14th minute. This information that JP 550 was overflying ZAG VOR at the same time as Trident Three and at FL 325, was received 29 seconds before the collision as well as crossing of FL 327 which was received 25 seconds before the collision.

The transcription of the TRIDENT TRHEE CVR tape revealed that both messages from JP 550 were recorded on the same tape which means that the crew may have heared them, but did not react. So important message received in the English language on the operational frequency (ZAGREB – "ADRIA

550 – ZAGREB – Good morning – Go ahead"; ADRIA 550 – "325 crossing Zagreb at 14'; ZAGREB – "What is your present level"; ADRIA 550 – "327") should have alerted the crew of BE 476 because it was said unambiguously and clearly enough that JP 550 would be at the same point (ZAG VOR) to which the crew of BE 476 was approaching. It could be also clearly seen from the messages that JP 550, corssing FL 325 and 327 was in immediate proximity of BE 476 in respect of altitude.

If the crew of BE 476 had listened – from the pilots' point of view – the information that an aircraft was in close proximity, in respect of place, time and altitude, certain reactions should have been caused. The fact that the crew of BE 476 i.e. the pilot-in-command, did not react to this message, could be seen from the following:

a) he did not comment in the cockpit, on any dangerous situation i.e. that an aircraft was at approximately the same altitude in respect to the point it was approaching and at the same time as they estimated to be over ZAG VOR;

b) he did not give any instruction (there is no record on the voice recorder) to the crew members on necessity for sharper lookout, as the weather conditions enabled so;

c) he did not askACC Zagreb any questions as what aircraft was in close proximity. The chance for such question existed in the pause between 14'17" and 14'22";

d) he did not take any maneuver to check the dangerous situation and possibly avoid the collision. Flight recorder did not register any change of maneuver.

29 seconds passed from the moment of the first message of JP 550, that it was crossing FL 325 and that it would be above ZAG VOR at 14' until the collision. From the moment FL 327 was reported there were 25 seconds until the collision and that was quite enough for the mentioned reaction by the crew which was not effected.

The absence of reaction might be a consequence of lowered tune on radio station (which is doubtful in this case because the crew was about to report overflying ZAG VOR), or the crew was passive in listening, which happens in practice, and did not react to such important detail that the other aircraft was in close proximity (AIR MISS).

On the basis of the same recordings of voice in the BE 476 cockpit it is evident that nothing distracted the crew during the last few minutes before the accident, to listen to radio communications and to lookout.

The transcription of ATC and CVR tape revealed that the Upper Sector controller did not inform the crew of BE 476 about the DC–9 aircraft in vicinity of ZAG VOR.

The aircraft was flying at the cleared flight level on the UB5 airway and when above ZAG VOR collided with the DC–9 aircraft.

B) The DC–9 aircraft

The aircraft operated a charter flight JP 550. After the take-off from Split the aircraft climbed over Split VOR on the airway B9, in the direction of Kostajnica NDB.

The crew used the economical climb regime (long range climb).

According to the instructions of Zagreb ACC the aircraft was in level flight at FL 260 for a period of 1 minute 48 seconds (from 10.05'57" until 10.07.45"), when it obtained a clearance from the Middle Sector Controller to climb to FL 350.

In climbing it passed Kostajnica NDB on the airway UB9 and assumed a heading in the direction of ZAG VOR.

At 10.12'12" the crew reported on Middle Sector frequency that they were switching to the Upper Secotr frequency to which they actually reported 1 minute 52 seconds afterwards though it is evident from the tape that in that period they were able to report four times in total time interval of 31 seconds during the radio communications interruption (5", 6", 13" 7").

At 10.14'10" the aircraft reported passing FL 325 and reported to the Air Traffic Control ZAG VOR at 14th (10.14').

At the time when BE 476 established radio contact with Zagreb ACC on the Upper Sector frequency, the DC–9 aircraft was flying in the Middle Sector maintaining radio communication on the Middle Sector frequency. Due to that the crew of DC–9 could not hear the message from the BE 476 crew.

On passing FL 325, in a critical phase of the flight, in relation to the position of the TRIDENT THREE aircraft, the DC–9 aircraft continued climbing to FL 350 in accordance with the ATC clearance.

Following a report from the DC–9 crew that they were passing FL 327, the controller required the aircraft to maintain its present level. Upon such controller's request the crew levelled the aircraft but at that moment the aircraft was already at the same level as the Trident Three aircraft.

On the basis of this request the crew could have assumed a serious conflict situation and sharpen the lookout. All this was happening 19 seconds before the collision when there was still enough time to take the avoidance action. Due to misunderstanding of this portion of the message, the crew of JP 550 asked again "what level". In this period the DC–9 aircraft continued to again altitude until 10.14'38" when the crew reported "O.K. maintain precisely 330".

Approximately 4 seconds before the collision the Air Traffic Control informed the DC–9 aircraft that they had an aircraft in front of them at 335 from left to right.

The crew of JP 550 did not fulfil its obligation to lookout from the cockpit though that was their duty according to Flight Operation Manual and the conditions existed because the visibility was good.

At FL 330 after it has levelled, according to the flight recorder readout (altitude parameter) the DC–9 aircraft collided with the TRIDENT THREE above ZAG VOR.

It was established that the collision occured exactly at 10.14'41". With the left wing in the length of 5 meters, the DC–9 struck the TRIDENT THREE cockpit and the crew of the DC–9 were not able any longer to control the aircraft though they were alive shortly afterwards.

c) Other factors relevant to the accident

It was established that before the accident there was no fire, explosion, attempted diversion or unlawful interference on board either aircraft.

The crew of both aircraft were properly certificated and qualified for the performance of their duties. They were also medically fit, rested and fully trained for the respective types of aircraft on which they were flying; there was also no influence of alcohol, drugs or narcotics. There was no engine malfunction on either aircraft during the prevous flight.

The aircraft were loaded within the approved limits.

The weather situation, visibility and the position of both aircraft before the collision were favourable enabling a good lookout and sighting of each other for the purpose of timely avoidance of collision.

The facts which prove this are the following:

- Weather report;
- At 10.04'45" i.e. approximately 10 minutes before the collision, the crew of the TRIDENT THREE aircraft reported that they had seen the aircraft of a Turkish airline at FL 350;
- The TRIDENT THREE aircraft was forming condensation trails. In support of this is a statement of the captain of Lufthansa aircraft who stated that the condensation trails behind the TRIDENT THREE were long at leat 10 NM;
- On the basis of statements of witnesses on the ground who saw the trails on the sky and on the basis of the fact that immediately before the collision the DC–9 aircraft was at approximately the same altitude as the TRIDENT THREE, it is supposed that the DC–9 was also forming the condensation trails;
- After the co-pilot had warned the captain of Lufthansa aircraft he saw the collision of two aircraft and their falling to the ground at the distance of 15 NM (about 25 km) and he immediately informed the Air Traffic Control. This fact indicates that the visibility was good;

- The attached scheme presents the data on aircraft position at 32 and 25 sec., beofre the collision. 32 seconds before the collision the distance between the aircraft was 13.600 meters. Viewed horizontally from the Trident Three cockpit the DC–9 aircraft was to the right at the angle of 28°30' which remained unchanged until the collision;
- Viewed horizontally from the DC–9 aircraft, TRIDENT THREE was to the left of the DC–9 at the angle of 29°30' which was constant until the collision;
- Viewed vertically, 32 seconds before the collision, the DC–9 was at the angle of 35' below the TRIDENT THREE. Vertically, the TRIDENT THREE was at the angle of 35' above the DC–9 aircraft;
- 25 seconds before the collision the distance between the aircraft was 10.625 meters. Angle values of the horizontal position were the same and remained unchanged until the collision. Viewed vertically the aircraft were at the angle of 25' in respect of each other;
- According to calculation, 16 seconds before the collision the DC–9 aircraft reached approximately the altitude of the TRIDENT THREE aircraft;
- According to calculation, 6 seconds before the collision the DC–9 aircraft reached maximum altitude above the TRIDENT THREE aircraft.

It comes out from the above that approximately 30 seconds before the collision the aircraft could have observed each other and that their inter-position in the field of vision, both horizontally and vertically did not change significantly but only the distance between them was changing until the collision. Thus their dimensions became larger.

On the basis of the traces on the destroyed fuselage of the Trident Three it was evident that the DC–9 struck the Trident Three fuselage with the left wing, probably from the low rate of descent due to the effect of autopilot or from the level flight so that the lateral positions of both aircraft left cutting traces on the Trident Three fuselage.

The azimuth angle of the sun was 166° with an angle in relation to the horizont of 48°. The angle of the sun as seen from either cockpit could have not restricted the visibility, i.e. the look out except that the crew of the DC–9 was in more favourable position in the direction of Trident Three.

All ground radio navigation aids on the airways UB9 and UB5 were technically serviceable without interruptions in operation.

After the accident both Primary and Secondary radar–SSR systems in operation at Zagreb ACC were found technically and operationally in order, with clear video maps and without interference.

Radio equipment for ground-air communication on the frequency 124.6 MHz, 135.8 MHz and 134.45 MHz was operationally serviceable; radio communications with both aircraft was maintained without interference.

Zagreb airport was equipped with all aids necessary for safe flying.

The flight recorders recorded all flight parameters from the take-off until the collision. They were used during the reconstruction of the flight. The quick access recorder from the TRIDENT THREE aircraft was not found.

The flight parameters revealed that both crews complied with their flight plans and that there was no deviation from the flight plan. The flight level 310 was indicated in the flight plan of JP 550, but as this flight level was not available, it was changed to FL 350 (according to Zagreb ACC clearance).

Radio-navigation aids of both aircraft were selected for the flight to ZAG VOR, except for the Nav. 1 receiver of the BE 476 which was still selected to Klagenfurt VOR.

It is probable that both aircraft were flying under control of the autopilot.

As the collision occured, it is evident that neither crew did take the manoeuver for avoidance of collision.

There was no manoeuvre (by both aircraft) as a result of insufficient lookout in favourable weather conditions and also of insufficient attention in listening to the messages on radio frequency, though both of these actions are permanent duty of pilots. There was no obstacle for mutual notice. Weather and other conditions were ideal what could be concluded from the following:

a) VMC flight conditions – see meteo bulletin;

b) Noticeable condensation trails behind the BE 476 aircraft in the length of 10 NM were seen by Lufthansa pilot at the distance of 15 NM;

c) Noticeable condensation trails seen by the witnesses on the ground;

d) Position of sun in relation to the aircraft path;

e) Positions of the aircraft and their relative movement within the field of sight from the cockpit (see the attached sketch).

Minimum increased listening watch to the frequency and minimum increased lookout by the crew, particularly at busy intersection of the airways, as ZAG VOR is, could have corrected the error of the air traffic control and prevent the collision. Numerous Air Miss reports show that in some hundred cases per year, the crew avoided the collision by application of appropriate procedures. This will happen as long as human factor is an essential element in realisation of safe flying.

The collision occured on the intersection of the headings 116^{o} and 353^{o} overhead ZAG VOR at FL 330.

Parts of the aircraft, equipment and baggage were scattered over large area (32 x 10 km) which caused difficulties in searching, gathering and identification of the wreckage of the aricraft and equipment. During the identification of the aircraft parts and during the reconstruction of the accident, great assistance was rendered by the aviation experts from Great Britain.

The evacuation of dead passengers and crews was made difficult due to swampy terrain and the fact that both aircraft and bodies were scattered over large area.

A great assistance during fire fighting, searching of terrain and evacuation of dead passengers was rendered by: Fire Fighting Brigades from Zagreb and Vrbovec, Agricultural-industrial Cooperative "Vrbovec", police units, medical teams, soldiers and people from the neighbouring villages.

2.2 ANALYSIS OF THE AIR TRAFFIC CONTROL OPERATION

The situation shortly before the accident began at the moment the clearance was given to the crew of JP 550 to climb from FL 260 to FL 350.

It has not been possible to establish definitively whether the Upper Sector controller approved JP 550 to climb to FL 350 estimating crossing Zagreb VOR at 10.16'[1)]. It was established that the Middle Sector controller cleared JP 550 to climb to FL 350. He did this previously retaining JP 550 in a level flight at FL 260. In this period (1'36") the coordination of this flight should have been carried out between the Middle and the Upper Sector. Due to conflict statements of the air traffic controllers i.e. the Middle Sector Assistant controller and the Upper Sector controller and due to lack of other evidence it was not possible to establish whether and how the coordination of this flight was effected.

If the coordination was effected it was effected improperly because there is no record on the tape neither the preparation was made i.e. writting of a new strip and transfer of the new strip to the Upper Sector.

On the corrected Middle Sector strip FL 350 was written without an arrow which should have indicated that the aircraft was climbing and the strip itself was retained in the Middle Sector until 10.12'12" i.e. when the Middle Sector controller instructed the crew of JP 550 to switch to the Upper Sector frequency.

The clearance issued by the Middle Sector to JP 550 to climb to FL 350 resulted in a situation, considering the climb speed characteristics, that in vicinity of Zagreb VOR it was crossing the altitude of BE 476 which was flying at FL 330. Thus, there was no possibility for the Upper Sector controller to separate the aircraft by procedural method.

---

1) The data extracted from the flight progress strip.

Had the request for climb of JP 550 been distributed to the Upper Sector by the Middle Sector in a form of separately prepared strip for the Upper Sector according to the Instructions on Zagreb ACC Operation, it is considered that the Upper Sector controller, with the strip in front of him, would have been informed about the proceeding of JP 550 and that he would have had a possibility to perform timely radar separation with the aircraft BE 476 or he would have not accepted the request at all.

When JP 550 reported passing FL 310, during the transfer of communication to the Upper Sector, the Middle Sector controller instructed the aircraft to SQUAWK STANDBY temporarily.

Had this instruction not been given, the code and altitude of the aircraft, which it has had in the Middle Sector after passing FL 315, would have been presented on the Upper Sector radar display together with a symbol of aircraft position which was constantly displayed, while the altitudes would vary according to climb of the aircraft.

Had the data on code and altitude of the aircraft been presented on the Upper Sector radar display the Upper Sector controller could have provided adequate radar separation between JP 550 and BE 476 i.e. could have prepared for the procedure of collision avoidance. The failure of the JP 550 crew, who reported to the Upper Sector controller with a delay of 1'52", made it even more difficult a possibility to take the measures for avoidance of collision.

The transfer of radar identity of JP 550 from the Middle to the Upper Sector was made physically as the target was shown by finger.

The use of "Julia" system enables each sector to select a layer by height filtering system, presenting all data available (position, descrete code and flight level) while for the rest of the airspace only aircraft positions are desplayed.

Each sector selects a layer, by height filtering system, which covers a part of the airspace under its responsibility, in order to avoid gathering and overlaping of codes and altitudes of its aircraft with those operating in other sectors.

Thus, all aircraft at FL 310 and higher were presented on the Upper Sector radar display with the codes, altitudes and position symbols. The aircraft operating below FL 310 were presented only with the position symbol.

In accordance with the above, all aircraft operating at flight levels between 250 and 310 were presented on the Middle Sector radar display with the codes, altitude and position symbols while all other aircraft, higher and lower, were presented only with the position symbols.

A controller in each sector may, if necessary, have on his radar display, the codes and altitudes of some aircraft operating out of the selected layer. He can achieve this in the following way:

a) feeding into a computer the code already transmitted by the aircraft operating in another sector;

b) requesting another sector to instruct the aircraft to transmit the code already fed into the computer;

c) using the "Pointer" facility which provides readout of codes and altitudes of any aircraft in duration of 30 seconds.

The Upper Sector controller did not use any of these possibilities because of the lack of time.

Programming of the computer by the controller is relatively complex operation which requires the use of a separate keyboard and display thus requiring the transmission of attention from the situation on radar display to other jobs.

The Upper Sector controller was aware of the situation only when the crew of JP 550 reported crossing FL 325 which was 29 seconds before the collision. In any case, the first call of JP 550 was delayed. The crew of JP 550 did not report to the Upper Sector controller from 10.12'12" until 10.14'04" though they could have done so during four pauses in radio communications which lasted 31 seconds (5", 6", 13" 7").

From 10.05'10" until 10.10'00" and probably until 10.13'00" during the critical phase, the Upper Sector controller was working alone without an Assistant controller who should have been at his post. The absence of the Assistant controller caused overloading of the Upper Sector controller. The Chief of the Shift was unaware of the absence of the Upper Sector Assistant controller though he was responsible to take care of the presence of all employees in the Shift.

At 10.14'10" when JP 550 reported crossing FL 325 and Zagreb VOR at 14th minute, the controller probably did not understand or believed the reported flight level. Therefore he asked the crew to repeat the level. The crew of JP 550 reported that they were passing FL 327 (phraseology in the English language).

At 10.14'22" the Upper Sector controller broke into Serbocroatian language in an attempt to stop the climb of JP 550 at the last reported level (327). From the moment the Serbocroatian language was used until the collision, there was 20 seconds, and when the controller reported to the DC–9 aircraft about the conflict traffic there were 4 seconds until the collision.

After this report the crew of JP 550 stopped climbing precisely at FL 330.

In respect of the Upper Sector controller's statement about the flight level of BE 476, it has been impossible to substantiate or deny his statement that the level readout before the collision was 332 or 335.

The flight level readout for the operation of the aircraft above German and Austrian territory was, according to the official report of the ATC from Munich and Vienna, 330.

The instruction of the Upper Sector controller issued to JP 550 to maintain its present level (while the aircraft was passing FL 327) suggests that he believed to achieve a vertical clearance of about 300 feet. However, the crew did not understand the instruction. The aircraft levelled at FL 330.

An important factor in the build up of the critical situation leading to the collision was the absence from his post of the Upper Sector Assistant controller. The Chief of the Shift did not take any action either to intervene or to help. He should have noticed the absence of the Assistant controller and the workload of the Upper Sector controller who was alone.

A series of the mentioned circumstances and departure from the published rules and regulations led to the aircraft collision.

3. CONCLUSIONS

3.1 On the basis of the data available and the analysis it is possible to eliminate the following as the cause of the accident:

- fire on board the aircraft and unlawful interference,
- medical condition and qualifications of the crews of both aircraft and the air trafic controllers,
- tehnical serviceability of the aircraft, engines and equipment of both aircraft,
- operation of ground radio-navigation aids,
- current meteorological situation

3.2 Contributory factors to the accident:

3.2.1 Absence of the flight progress strip for JP 550 for a portion of the flight within the Upper Sector of Zagreb ACC, which is contrary to the Instructions on operation of ACC Zagreb. This resulted in the Sector's overlooking of the previous information about this flight and untimely planning and safe aircraft separation.

3.2.2 Absence of the Upper Sector Assistant controller from his duty post from 10.05'10" until 10.10' and probably until 10.13', during a period when the Upper Sector controller's workload was high.

3.2.3 Unawareness of the Chief of the Shift about the Upper Sector Assistant controller's absence and not taking of the appropriate measures to put that in order because that was his duty.

3.2.4 The instruction of the Middle Sector controller to the JP 550 aircraft to switch the transponder to "STANDBY" unabled the Upper Sector controller to sight in time and to follow vertical movement of the JP 550 aircraft and to carry out the separation procedure.

3.2.5 Overloading of the Upper Sector controller due to the absence of the Assistant controller, lack of the flight progress strip which should have been prepared by the Middle Sector for the Upper Sector in accordance with the Instructions and also the switching of the transponder to "STANDBY", unabled the Upper Sector controller to sight in time the conflict situation and take the appropriate measures for the avoidance of collision.

3.2.6 Improper coordination between the Middle and the Upper Sector during the issue the clearance to JP 550 to climb to FL 350 without provision of adequate procedural separation against BE 476. The Middle Sector did not prepare a new strip for the Upper Sector according to the Instructions on Operation of ACC Zagreb.

3.2.7 Delayed report of JP 550 to the Upper Sector frequency of 1 minute 52 seconds.

3.2.8 Non-compliance with FOM procedures by the crew of the DC–9 aircraft concerning the duty to lookout from the cockpit.

3.2.9 Non-compliance with FOM procedures by the crew of TRIDENT THREE aircraft concerning the duty to lookout from the cockpit.

3.2.10 Passive listening of BE 476 to radio communications on the ATC frequency due to which the crew did not realise a conflict situation and immediate danger from the message of JP 550 on passing FL 325 and FL 327, reported in the English language 29 and 25 seconds before the collision. The message also contained the time (14 min.) above ZAG VOR and that was the time BE 476 estimated ZAG VOR. On the basis of this data the crew of TRIDENT THREE could have concluded that the DC–9 aircraft was in close proximity, in climb and could have realised the seriousness of the situation.

3.3 CAUSES OF THE ACCIDENT

3.3.1 Direct cause of the accident was the struck of the DC–9 wing into the middle side of the TRIDENT THREE fuselage which occured at the height of 33.000 feet above Zagreb VOR so that both aircraft became uncontrollable and fell on the ground.

3.3.2 Improper ATC operation.

3.3.3 Non-compliance with regulations on continous listening to the appropriate radio frequency of ATC and non-performance of look-out duty from the cockpits of either aircraft.

ADDENDUM BY THE UNITED KINGDOM TO THE REPORT BY THE SECOND YUGOSLAV COMMISSION OF INQUIRY INTO THE TRIDENT/DC9 MID-AIR COLLISION AT ZAGREB ON 10 SEPTEMBER 1976

As United Kingdom Accredited Representative I have participated in the re-examination by the Second Yugoslav Commission, of the circumstances that led to the Trident/DC9 mid-air collision at Zagreb and I consider that the following comments are necessary in order to give a proper balance to the report.

1 The information presented in the report concerning in-flight look-out is, in the United Kingdom view, inadequate and has not been realistically examined.

The report simply quotes the extracts from the Flight Operations Manuals that refer to In-Flight Look-Out, then concludes that because the aircraft collided, the crews cannot have been fulfilling their duty to maintain a proper look-out.

This question cannot be considered without reference to the difficulty in locating an aircraft which maintains a constant angular relationship and approaches at very high speed, in this case a closing speed of 850 miles per hour (738 knots). The Commission has failed to take account of the considerable amount of research that has been conducted on this subject.

In addition there were significant differences in viewing conditions between the Trident and the DC9. The DC9 crew were looking down sun, a direction that gives optimum visual conditions, for an aircraft that was producing a persistent condensation trail. The Trident crew however were looking into sun, a direction that gives a poor visual resolution for an aircraft that, was possibly not producing a condensation trail.

2 The United Kingdom disagrees with Conclusions 3.2.8 and 3.2.9 in that there is no evidence presented in the report that could lead to the conclusion that the crews of both aircraft were not complying with the Company Flight Operations Manual requirement to maintain a look-out. The only conclusion that could be drawn on this aspect is that neither crew saw the other aircraft.

3 The report gives equal weighting to two causal factors in Section 3.3. '3.3.2 – Improper ATC operation' and '3.3.3 – Non-compliance with regulations on continuous listening to the appropriate radio frequency of ATC and non-performance of look-out duty from the cockpits of both aircraft'.

The evidence presented in the Report does not, in the United Kingdom view, support the statement at 3.3.3 that the crews did not comply with the Flight Operations Manual requirement to maintain a look-out and to continuously monitor the appropriate ATC frequency.

The Trident and the DC9 were, at the time of the collision, under the control of Zagreb ATC who were solely responsible for aircraft separation. Both aircraft were complying with ATC instructions and it was these instructions which caused the aircraft to collide.

It is clear, therefore, that the cause of the accident was the failure of the ATC system to provide the required separation.

K P R Smart
United Kingdom Accredited Representative

'READERS OF THIS ACCIDENT REPORT SHOULD BE AWARE THAT NOT ALL THE TABLES, ATTACHMENTS, SKETCHES OR PLANS REFERRED TO IN THE TEXT OF THIS REPORT HAVE BEEN MADE AVAILABLE TO THE UNITED KINGDOM AUTHORITIES.'

Produced in England by Her Majesty's Stationery Office, Reprographic Centre, Basildon
Bas 250659/R151 750 4/83 TP