HELLENIC REPUBLIC

MINISTRY OF TRANSPORT AND COMMUNICATIONS

AIRCRAFT ACCIDENTS INQUIRY COUNCIL

AIRCRAFT ACCIDENT REPORT

17.12.1997

AEROSWEET AIRLINES, FLIGHT AEW-241

YAK-42, UR-42334

"MAKEDONIA" INTERNATIONAL AIRPORT

THESSALONIKI HELLAS

The investigation of the accident was carried out by an independent committee, which comprised:

-Captain Akrivos Tsolakis, Investigator in Charge
-Nikos Gouleas, H.A.F. Lt. Gen. (Ret)
-Athanassios Rigos, Aeronautical Engineer
-Antonis Koutsoudakis, Air Traffic Controller/PPL
-Ioannis Papadopoulos, Chief Accident Investigation Section
-Evangelos Kyriazis, Electronic Engineer/M
-Charalambos Kaiklis, Aeronautical Engineer/Operation Officer
-Sotirios Stamou, Aeronautical Engineer
-Nicolas Rammos, Major H.A.F.
-Pandelis Aronis, 1st Lt. MD-H.A.F.

According to the provisioned procedure by ICAO, in annex 13, Accredited Representatives and their Advisors, from Russia and Ukrane, participated in the investigation.

On June 17, 1998, according to the provisioned procedure by ICAO, in annex 13 (ch. 6, para 6 and 9), a copy of the final report draft was sent to Russia(state of the manufacturer) and Ukrane (state of registration) inviting their comments.

On August 8, 1998 the comments of the Accredited Representative of Ukrane were received and are attached herewith. On August 12, 1998 the comments of the Russian representation were received, adopted, integrated in the final report and are attached herewith.

The report was issued by the Aircraft Accidents Inquiry Council, as provisioned by Law 1815/88 (ratification of the code of the Aviation Law).

AIRCRAFT ACCIDENT REPORT

REGISTRATION	**: UR-42334**
TYPE OF AIRCRAFT	**: YAK-42**
NATIONALITY	**: of Ukraine**
OWNER	**: Lviv State Aviation Enterprises**
OPERATOR	**: Aerosweet Airlines**
NUMBER OF ENGINES	**: Three**
TYPE OF ENGINES	**: Turbojet D-36**
PLACE OF OCCURENCE	**: Pieria Mountains (Pente Pirgi)**
DATE	**: December 17, 1997**
TIME	**: 19:12' 43" UTC**
TYPE OF FLIGHT	**: Passenger Sceduled**
NUMBER OF PASSENGERS	**: 62 plus 8 Crew members (according to the official list)**

All times in this report are UTC

Local time, when the accident took place, was UTC+2

By the Ref. No 6674/03.09.98 resolution of the Minister of Transport and Communications, the Aircraft Accidents Inquiry Council (AAIC) was convened, as provisioned in article 146 in Law 1815/88, in order to decide on the cause of the aircraft accident of the YAK-42 (UR-42334) Aircraft of Lviv State Aviation Enterprises, that occured on December 17, 1997, in a mountaneous terrain close to the city of Katerini, southwest of the Thessaloniki 'MAKEDONIA" Airport, during its missed approach for RWY16.

SYNOPSIS

The UR-42334 Aircraft, performing Flight AEW-241, operated by AEROSWEET Airlines of Ukraine, on a regular scheduled passenger flight from Odessa International Airport, Ukraine, to "Makedonia" International Airport Thessaloniki Hellas, was approaching by VOR/ILS procedure, for landing on runway 16. Executing the missed approach procedure, due to having not the runway in sight, following a path of significant deviation from the anticipated one, crashed onto mountainous terrain of Katerini with result the death of all occupants and the total loss of the aircraft.

1. FACTUAL INFORMATION

1.1. History of Flight

At 19:12':43" UTC (Universal Coordinated Time) on December 17, 1997, Flight AEW-241 operated by AEROSWEET Airlines of Ukraine, a YAK-42 aircraft, on a regular scheduled passenger flight from Odessa International Airport, Ukraine, to Makedonia International Airport Hellas, operating at night under instrument flight rules (IFR), crashed onto mountainous terrain AEW-241 made a VOR-DME-ILS missed approach for landing on runway 16, but significantly deviated from the missed approach procedure in instrument meteorological conditions (IMC). The accident site was near the town of Katerini, 37 NM south-west of Thessaloniki Airport.

The aircraft impacted at 3,300 feet MSL[1] near the summit of "***Pente Pirgi (five towers) on a heading of 290°, 20° right bank, 15-20° nose-up attitude and an indicated airspeed of 0.347 Mach (216 kt, 400 km/h)***". The aircraft was completely destroyed and all crew (8) and passengers (62)* were fatally injured.

On the previous flight the same crew flew the aircraft, from Lviv to Odessa. The flight crew reported for duty at Lviv at 11:20' UTC. The flight departed Lviv at 14:07' UTC and arrived Odessa at 15:23' UTC, with Nº 1 VHF/NAV inoperative. After an approximate 30 minute ground test by ground personnel, flight AEW-241 departed Odessa at 17:23' UTC with ETA[2] at Makedonia Intl' at 19:03' UTC. The load message indicated 70 persons aboard (62 passengers and 8 crew).

In conformity with the relative agreement with Olympic Airways, the particular flight sould normally be carried out using Aerosweet Boeing 737 type of aircraft. But in this instance the Boeing aircraft was grounded for mechanical problems, so Aerosweet contracted with Air Lviv for the use of a YAK-42 aircraft and crew, to fly this mission.

The flight proceeded through Ukrainian and Bulgarian airspace. Departing Sofia VOR along ATS Route 35 the flight entered Hellas airspace at CCO (Chouchouligovo) at 18:39':31" at FL 230 and squawking transponder code 6131. The flight within Athinai ACC was entirely in darkness. The weather was typical winter weather(with cloud cover at levels), but with good visibility below clouds.

* see 1.2.s

(1) M.S.L. = Mean Sea Level

(2) E.T.A. = Estimate Time of Arrival

Flight AEW-241 initially contacted MAK/APP[3] while the controller was involved in controlling the descent and arrival of an O.A.[4] flight. Part of AEW-241's initial communication was blocked by simultaneous transmission of another station and the controller clarified that his descent instructions to 3,500 feet QNH etc were concerning the O.A. flight.

The communications transcript (Appendices 12 to 15) indicated that AEW-241 mistakenly responded to this communication by stating that it was descending in accordance with the controller's clearance to 3,500 feet QNH. The controller immediately corrected AEW-241 that the instruction was not meant for them and asked AEW-241 to stand by. Following a position report from the other flight, that they were clear and starting their approach, MAK/APP cleared AEW-241 to descend to FL100, to expedite the rate of descent and to report LAMBI. MAK/APP also gave AEW-241, clearance limit of the north holding pattern, with an approach sequence that AEW-241 was number two for a LAMBI 1F arrival and VOR-DME-ILS approach to runway 16 (Appendix 12). The communication proceeded normally until LAMBI. In the sequel, however, confusion started to prevail in and cockpit as well as management breakdown.

The flight did not follow the "arc" of LAMBI 1F arrival(see Appendix 4), as instructed by ATC, but proceeded instead on a course towards THS/NDB, as marked with yellow colour on Appendix 1. As a result of this deviation the GPWS[5] gave alarm signals twice (18:47':24" and 18:49':41"). The crew did not react to neither alarm signals except for a comment about mountains on

(3) MAK/APP = Makedonia Approach

(4) O.A. = Olympic Airways

(5) G.P.W.S. = Ground Proximity Warning System

the first occasion. The aircraft overshot the localizer course at least twice, in trying to establish on the localizer course. By not following the published procedure for transitioning to and engaging the localizer (utilizing the "arc") and with the rapid descent required, the flight crew was unable to establish a stabilized approach.

As a result AEW-241 arrived at the airport boundary high and passed over the airport with indications from the CVR[6] that the crew due to disorientation did not realize it.

The controller informed them at 18:54':37" that they had passed the airport. Internal cockpit conversations indicated crew disorientation and confusion as to the course they were to fly and at 18:55':03" they requested a "***heading***" from MAK/TWR. The controller answered that they were unreadable and requested AEW-241 to contact approach control on 120.8. The frequency change was acknowledged by the flight crew.

As AEW-241 proceeded beyond the airport, they reported on heading 150° and responded to the controller's request for their level with "***1,500 feet***". The controller requested information whether AEW-241 was south of TSL on Radial 150°. AEW-241 affirmed "***Radial 150***". MAK/APP acknowledged and instructed the crew to continue outbound climbing to 6,000 feet (QNH 1035). The clearance was acknowledged by AEW-241 at 18:56':12". MAK/APP further instructed them to remain in the south holding at 6,000 feet and continue on radial 150 outbound, ascending to 6000 feet. MAK/APP then turned its attention to an inbound O.A. flight.

(6) C.V.R. = Cockpit Voice Recorder

At 18:57':58" MAK/APP instructed AEW-241 to continue climbing 6,000 feet and "***To turn right proceeding inbound TSL/VOR***". AEW-241 acknowledged this with "***To turn right inbound TSL***". The CVR revealed further cockpit confusion and indications of disorientation with the instructor pilot (I/P) asking "***Where to go to ?***" and flight engineer (F/E) complained "***Do not shout***" (CVR #46 18:56':46" through 18:57':35"). MAK/APP requested AEW-241 to report TSL VOR maintaining 6,000 feet which was acknowledged by the flight crew.

It was after this point that the crew became involved in attempting to tune the VOR, and continuing the turn towards TSL. The captain (P) stated (CVR #49 18:58':49" through 18:59':19") "***So, which heading should be taken, take a look***", co-pilot (C/P) "***To the right. He has given a VOR to you***", captain (P) "***I've got ADF set-up***", instructor pilot (I/P) "***Set-up the VOR. Go ahead to the VOR, go to the VOR***", captain (P) "***To which VOR ? Well we should (tune?-go?) to the left***".

The controller requested AEW's position at 18:59':20". AEW responded : "***6,000 feet five (5) miles from TSL***", MAK/APP acknowledged "***Roger, radial established inbound ? Report radial established inbound ?***", AEW-241 responded "***Will be radial established***". At 18:59':46" MAK/APP acknowledged AEW-241 "***Maintaining 6,000 feet***" and instructed them to "***Report over TSL/VOR***". AEW-241 responded "***Maintaining 6,000 feet will be report TSL***".

There followed more confusion in the cockpit over setting up the VOR, with the instructor pilot questioning whether the VOR signal worked or not. At 19:00':11" one of the crew remarked "***Reach 6,000 feet Lyosha***". MAK/APP requested again confirmation from AEW-241 that they were maintaining 6,000 feet and received an affirmative response from the flight

crew, while at the same time CVR revealed that they had not yet reached 6,000 feet (*"reach 6000, Lyosha"*). At 19:00':20", MAK/APP transmitted: *"Maintaining 6000, 241 report over MIKRA VOR"*. AEW-241 again responded affirmatively : *"Roger report MIKRA VOR ... AEW"*. Within the flight deck the instructor pilot (I/P) immediately said : *"Reach, reach please"* and the captain (P) responded : *"I can not"*. The flight data recorder (FDR) indicated that flaps were still extended to 20° at this time while the flight was in a climb mode and having difficulties to reach the assigned altitude.

At 19:00':38" further intra-cockpit conversations indicated that the flight crew was preoccupied with tuning and interpreting the navigation instruments in the cockpit. At 19:01':08" MAK/APP again asked : *"AEW-241 have you passed over TSL proceeding MIKRA VOR ?"* and AEW-241 responded that they were *"Proceeding TSL"*. At 19:01':34" the VOR seemed to be tuned and the co-pilot noted *"We're already passing outbound"*. At 19:01':52" the captain remarked *"Flaps at 20° set-up. Let them stay"*.

The controller requested AEW-241's position at 19:02':19" and the flight crew responded : *"Position ten (10) miles from TSL"*. The controller asked : *"You are ten DME outbound TSL to the North ?"*, AEW-241 responded : *"Affirm"*. MAK/APP asked : *"Radial 344 outbound ?"* AEW-241 responded : *"Radial ..."* without completely answering the controller. After an intervening transmission to a domestic flight, the controller instructed AEW-241 at 19:02':56", to *"... continue to the north hold, north hold descend 4,500 feet, QNH 1035 within north hold"*. Some intra-cockpit conversation repeated *"North hold, northern zone of holding"* after which AEW-241 responded to MAK/APP : *"Continue passing north hold descending 4500, QNH 1035"*.

At 19:03':26" MAK/APP again asked AEW-241 if they were north of TSL. AEW-241 responded : "*Yes, north TSL, AEW*" while at the same time the co-pilot in the cockpit said : "*He is asking if we are north*". With the affirmative response the controller at 19:03':43" instructed : "*AEW-241 roger, continue descending 3,500 feet on QNH 1035 clear VOR-DME-ILS approach to RWY 16 report establishing LLZ*[7] *number one*". The crew responded : "*Descending 3,500 feet QNH 1035 report established LLZ RWY 36 ... 16*".

Following this, intra-cockpit crew conversations were involved with discussing radio frequencies, headings, altitude and a mention by the instructor pilot that "*So... we are passing 270°* " and a moment later this confirmed by the co-pilot who stated "*Heading 270° we are passing*".

At 19:05':00" the captain asked the instructor pilot : "*You Lyosha, give him heading and altitude*". There followed further intra-cockpit discussion,
C/P : "*Which ADF ? Is locator in operation ?*".
Captain : "*Tell him... ask him for vectoring*",
I/P : "*Does the ADF work ? This one, this*","*What is on the second (ADF)?*"
F/E : "On the second (ADF) 348[8] *is tuned*",
I/P : "*What is tuned on the second ?*",
∃[9] : "*345 (TSL/ADF frequency). Yes, 240...270*",
captain : "*You add (power)*", C/P : "*Speed, speed*".

At 19:05':30" the controller again asked for AEW-241's position and the crew responded "*Position now ... 8 miles DME from TSL*". The controller asked : "*You are north of TSL 8DME confirm ?*",

(7) LLZ = Localizer

(8) 348 = The frequency of Odessa ADF

(9) ∃ = Symbol for an unidentified voice

the crew responded : "*Affirm*", after which at 19:05':58" the controller said : "*241 Roger continue VOR-DME-ILS approach, report establishing LLZ*". The crew responded : "*OK will be report established LLZ on RWY 16*".

At 19:06':12" the captain said (CVR) "*Stop. I don't understand what have you taken ? Which heading we're passing ?*".
The copilot responded, "*Two seven zero*", the instructor pilot said : "*We're passing*" the captain again repeated "*What have you taken?*" and the instructor pilot suggested : "*Let's go, turn on 160°*".
At this time the FDR showed that the heading was indeed 270°. The flight crew continued to comment on altitude, speed and heading and at the end the captain instructed the crew, "*Ask for vectoring*".

At 19:07':50", AEW-241 asked : "*Makedonia AEW-241, if possible, request vectoring RWY16*". The controller was working on another domestic flight and responded, "*AEW-241 say again please ?*" The crew repeated, "*Request route vector*". The controller replied: "*There is no radar vectoring here, Sir, there is no. We don't, we don't ... can afford radar vectoring. Please comply with VOR-DME-ILS approach RWY16*". AEW-241 responded, "*Affirm*". MAK/APP further instructed: "*Report establishing the LLZ of RWY 16, 3,500 feet*", to which the flight crew answered : "*Roger, report you LLZ*". This exchange with ATC was followed by more intra-cockpit discussion of problems in navigating, operating the radio navigation equipment, determining what track they were on, etc, until 19:09':38" when MAK/APP again requested AEW-241's position. The crew responded, "*Position ... 28 miles*". The controller then asked, "*Roger, AEW are you able to comply with VOR-DME-ILS approach 16 ?*", within the cockpit, the CVR picked up the comments: "*Have you got an approach to RWY16 ?*" , "*Well, where are we going ?*", after which the crew responded to the controller, "*Wilco AEW*".

MAK/APP asked, "*AEW-241 do you know the procedure for VOR-DME-ILS approach ?*", AEW-241 responded, "*Now ... proceeding VOR ... 3,500 feet confirm ?*". The controller answered : "*Affirmative Sir, establish LLZ of ILS at 3,500 feet, then comply with ILS approach RWY16 to the minima, to the published minima*". AEW-241 replied, "*OK*".

At 19:10':38" through 19:11':48" the crew engaged further in intra-cockpit discussion of difficulties in navigation and orientation and a remark was made by the instructor pilot : "*So Lyosha, let's orient ourselves, we are passing outbound the locator now heading 210°, so where the locator should be ?*" the captain responded "*Well it's behind* ", an unidentified voice said : "*... look at the chart*" and the copilot added : "*We should turn to the left*". Then the conversation was concerned with the tuning of the ADF, with confusion as to which ADF was set on 345 (Thessaloniki NDB) and what was being displayed.

At 19:11':34" the flight engineer(F/E) stated that the ADF was set up and the copilot said : "*Come on to the locator*". The captain then said : "*So, turning right, we take heading onto locator*". This was followed by "*Listen, let's get the flaps cleared*", "*Let's increase the speed then*", "*Increasing speed, clear the flaps off*" and finally the copilot stated : "*Being cleared off*".

At 19:11':51" MAK/APP asked AEW's altitude, but in Greek language. AEW-241 answered "*3,500 feet*". The controller came back with "*Roger, have you established the LLZ ?*" There was no immediate answer from the crew, but internally the copilot said : "*Turn right*" and the captain added : "*Turn right now* ". Then AEW-241 announced to the controller : "*Turn right to beacon*".

At 19:12':08" the GPWS sounded for 4 seconds. The instructor pilot asked : "***Bank ... speed normal ?***" and the flight engineer responded : "***It is normal***".

At 19:12':13" MAK/APP called : "***AEW number one, continue VOR-DME-ILS approach minima, continue and report approaching the outer marker***". The crew answered : "***Outer marker will be report***". After a while MAK/APP asked "***AEW-241, do you have the field in sight ?***". At that time, 19:12':32", the GPWS sounded again, followed by intra-cockpit alarmed voices : "***Come on climb, climb***" , "***The panel (warning) light 'Dangerous Ground' is lit***" , "***How much did you say to climb***" , "***How much have you told me to climb ?***" This was the last message on the CVR.

At 19:12':43" the GPWS alarm turns off. MAK/APP attempted to call AEW-241 until 19:20':19". Meanwhile Military Radar was notified and Search and Rescue was alerted.

The wreckage of the aircraft was found after 3 days, due to adverse weather conditions, in an unpopulated, wooded mountainous area at an elevation of 3,300 feet MSL.

1.2. Injuries to Persons

Injuries	Flight crew	Cabin Crew	Passengers	Total
Fatal	4	4	62	70
Serious	0	0	0	0
Minor	0	0	0	0
None	0	0	0	0
Total	4	4	62	70

* In accordance with the Coroner's Report there were 4 additional bodies found. This case is to be further investigated by the appropriate authorities in Ukraine, and is not in accordance to the submitted Passenger manifest, the weight and balance Sheet and the Flight Plan.

1.3. Damage to Aircraft

The aircraft was completely destroyed.

1.4. Other Damage

No damage to third party persons or property was caused by this accident except for a small portion of uninhabited mountainous wooded area.

1.5. Personnel Information (Appendix 17)

All cockpit crew members were certified by the State Department of Aviation Transport of Ukraine, to hold their respective positions in the YAK-42 aircraft and each member possessed a current medical certificate. None of the flight crew was involved in an accident in the past.

The position of crew members in the cockpit were as follows:

- Instructor Pilot: Right seat
- Captain: Left seat
- Co-pilot: Jump seat (assumed)
- Flight Engineer: Flight Engineer's seat

1.5.1. Cockpit Crew

1.5.1.1. Instructor Pilot

Male: 51 years of age

Nationality: Russian

License: Nº 004069 - 22.10.84 valid 07.02.98

Medical Certificate: 20.1.97

Total flying time: 16210 hours

Total flying time YAK-42: 5350 hours, in command 5150 hours

Total flying time last 90 days: 38 hours 47'

Total flying time last 60 days: 30 hours 58'

Total flying time last 30 days: 4 hours 05'

Total flying time last 7 days: 4 hours 05'

Total flying time last 90 days on international flights:10 hours 33'

Hours on duty prior to accident: 8 hours 03'

Hours off duty prior to work: more than 24 hours

Accident flight hours: 1 hour 49', 45"

English language license: Nº 10/6.4.88

International flight license: Nº 245/27.8.90

1.5.1.2. Captain

Male 49 years of age

Nationality: Russian

License: Nº 004045 - 22.10.84 valid 23.10.98

Medical Certificate: 22.4.97

Total flying time: 9850 hours

Total flying time YAK-42: 2300 hours, in command 470 hours

Total flying time last 90 days: 43 hours 35'

Total flying time last 60 days: 20 hours 02'

Total flying time last 30 days: 20 hours 02'

Total flying time last 7 days: None

Total flying time last 90 days on international flights: None

Hours on duty prior to accident: 8 hours 03'

Hours off duty prior to work: more than 24 hours

Accident flight hours: 1 hour 49', 45"

English language license: Nº 62/31.12.89

International flight license: Nº 4/1.3.93

1.5.1.3. Co-pilot

Male 40 years of age

Nationality: Russian

License: Nº 016152 valid 19.11.98

Medical Certificate: 12.11.97

Total flying time: 6700 hours

Total flying time YAK-42: 3000 hours

Total flying time last 90 days: 68 hours 04'

Total flying time last 60 days: 33 hours 44'

Total flying time last 30 days: 04 hours 05'

Total flying time last 7 days: None

Total flying time last 90 days on international flights: None

Hours on duty prior to accident: 8 hours 03'

Hours off duty prior to work: more than 24 hours

Accident flight hours: 1 hour, 49', 45"

English language license: 19.8.93

International flight license: Nº 171/17.12.96

1.5.1.4. Flight Engineer

Male 43 years of age

Nationality : Ukrainian

Medical Certificate : Current

License : Nº 018158 valid 29.3.98

Total flying time : 4036 hours

Total flying time YAK-42 : 3,900 hours

Total flying time last 60 days : 32 hours 57'

International flight License : Nº 28 - 29.2.95

Accident flying hours : 1 hour, 49', 45"

Hours of duty prior to accident : 6 hours

Hours of duty prior to work period : According to the regulations

1.6. Aircraft Information

The aircraft, a YAK-42 Ser. Nº 4520422606164, was manufactured in 1986 and delivered to Aeroflot in June 1986. It was transferred in September 1992 to Air Ukraine and in 1996, it was transferred to Lviv Aviation Enterprises, an associated State owned company. On November 1997 it returned from a seven month lease period to Tiger Air, a Yugoslavia based charter company. The accident flight was operated under wet-lease agreement with Aerosweet Airlines.

Before the accident flight, the aircraft had accumulated 12,008 flight hours and 6,836 cycles, since new. The aircraft was equipped with three model D-36, three shaft, by-pass turbojet engines, each rated at 14,331 lbs of take-off thrust. Nº 1 engine, Ser. Nº 2253604401019, manufactured in December 1984, had accumulated 8,418 hours since new and 831 cycles

since last overhaul. Nº 2 engine, Ser. Nº 7083603001089, manufactured in December 1990, had accumulated 4,883 hours since new and 831 cycles since last overhaul. Nº 3 engine, Ser. Nº 708036721A002, manufactured in May 1987, had accumulated 5,936 hours since new and 989 cycles since last overhaul. Fuel used was Russian made with specifications corresponding to JP-1 or Jet A-1 ones.

According to a written statement signed by the Ukraine accredited representative for Accident Investigation (Appendix 35 and 36), there were no malfunctions or outstanding maintenance items on the aircraft prior to its departure from Lviv to Thessaloniki, via Odessa on December 17, 1997. Last periodical maintenance check was performed on December 11, 1997. In addition, there was no list of Carry Forward Defects. A copy of the Airworthiness Certificate (not signed), expiring June 10, 1998, has been submitted (Appendix 25).

The YAK-42 aircraft is designed by the Yakovlev Design Bureau in accordance with the (former) USSR Civil Airplane Airworthiness Regulations, considering also the FAR requirements and meets up-to-day flight safety requirements. It is intended for short-haul and local route operations for passenger and cargo transportation.

The equipment on the aircraft (flight, navigation, monitoring, communication and electrical system) provided for air navigation along equipped and non-equipped airways, in any environmental conditions and any geographical regions, in any period of the day or the year. The fulfillment of this purpose was reached by the modification installation of an additional small control panel on top of the cockpit center instrument panel, enabling the

selection of DME channels for compliance with "western type" VOR-DME-ILS approach procedures. An inquiry, by the Board, to the Ukrainian accredited representative for Accident Investigation, to have a copy certificate of the authorized accomplishment of subject modification, has not been satisfied. However, Yakovlev (the authorized modification center, as designer and manufacturer of the aircraft) stated that such information, concerning the modification accomplishment on YAK-42 UR42334, has not been recorded by them (Appendix 37-B).

The aircraft had been maintained by the Lviv State Enterprise. In order to get an idea about the kind and extent of maintenance work accomplished and the way the malfunction on N^{o} 1 VOR receiver, witnessed by the ILS localizer capturing incapability (FDR) had been anticipated, several working documents have been requested (Appendix 38).

A copy of the sub-chapter 4.26 (LIST OF ALLOWABLE FAILURES AND MALFUNCTIONS) of the (approved) Flight Manual (Appendix 28) and Appendix 39 were the answer to requests for the MEL, the Maintenance Certificate and Maintenance Schedule (see appendix 38).

Not submitted required documents (requested as per Appendix 38), concerned significant items assuring the continuous airworthiness of the aircraft, were finally covered by the statement in Appendix 35 as previously mentioned, signed by the Ukraine accredited representative for Accident Investigation and consequently assuming the responsibility that the aircraft . . . . "was let out for flight operations on the route Lviv - Odessa - Thessaloniki in accurate condition".

During approach for landing in Odessa, the Nº 1 VOR receiver became inoperative (witnessed through the FDR Localizer capturing parameter readout for a series of flights before the accident). 24' minutes FDR ground run, points very likely to an attempt to rectify the malfunction. Although no positive result had been achieved, somebody has taken the decision (and the responsibility), that the flight be continued to the final destination (Thessaloniki).

The aircraft left Odessa on a scheduled commercial flight with Nº 1 **(Pilot)** VOR receiver inoperative, despite the fact that the MEL[10] procedures allow this condition only for a return flight (not commercial) to the base aerodrome and only in case the **co-pilot** unit or instrument has a mulfunction (Appendix 28, MEL page 14 and 16).

When the aircraft left Odessa it was **NOT** in an "accurate condition", on the contrary it was in a not fully airworthy condition, violating the requirements for safe operations.

1.6.1. Weight and Balance Information

The aircraft weight and balance was determined by Aerosweet Airlines in Odessa. The aircraft was loaded with 9,500 kg of fuel for take off from Odessa on December 17, 1997. Its actual take off weight was determined as 48,408 kg. The center of gravity (C.G.) at take off was determined to be 27.12 percent of the mean aerodynamic chord (MAC). The take off weight and C.G. were within limits for take off.

(10) MEL = Minimum Equipment List

The calculated fuel burned prior to impact was 4,500 Kg. The aircraft at impact gross weight was 43,908 kg.

Above, first paragraph data emerge from a computerized LOAD SHEET (Appendix 22,A) which stays in discrepancy with the superficially and insufficiently filled out (a balance chart is not included) LOADSHEET & LOADMESSAGE FORM (Appendix 22,C), concerning the information on actual crew members and their occupation on board.

The former mentions 4/3 crew while the latter mentions 6/2 crew. There were 4 flight crew members and 3 cabin crew members or 6 flight crew members(!) and 2 cabin crew members?
YAK-42 standard specification (Appendix 40) and information DATA (Appendix 41), call respectively for the following :

"2.5.1. The airplane flight crew shall consist of :

Pilot (Captain).

Co-pilot.

Two cabin attendants." , and

"The crew consists of two pilots : the captain (pilot) and the co-pilot.

Besides, two cabin attendants also pertain to the crew.

The aircraft is simple in operation and is easily mastered by the pilots and engineering personnel".

From the aforementioned, it is not clearly indicated whether the "**flight engineer**" is part of the flight crew.

Flight compartment seating arrangement (Appendix 40) allows for two pilots (pilot - in command and co-pilot). A jump seat, which flaps upward on the sidewall of one of the two circuit breaker panel boards of the cockpit, is

deployed when in use, near and in line with the central pedestal, in the narrow corridor (one man's shoulder width) formed by these boards.

Above specification / information remains in discrepancy with the data in paragraph 1.5, which reflect the relevant information provided by the operating company, justifying the impression of an overcrowded cockpit during the accident flight.

Furthermore, there is a severe discrepancy concerning the number of passengers on board. As already reported in 1.2., in accordance with the Coroner's Report, four (4) additional bodies were found, as compared to the number reported in the passenger Manifest and the Load Sheet & Load Message Form. This case is to be investigated in depth by the appropriate Authorities and if the presence of the four(4) nondeclared passengers is confirmed, it would constitute a major problem concerning the reliability of the company with respect to its obligations to IATA and the regulations of ICAO.

Nevertheless, it must be noted that, as no abnormal trim corrections have been recorded on the FDR, apparently the discrepancies in the Weight and Balance Sheets versus the actual data, had no influence on the flight characteristics of the aircraft, not constituting for this reason a contributing factor to the causes of the accident.

1.7. Meteorological Information

1.7.1. Makedonia Airport

Weather over Makedonia Airport on the night of the accident, was typical winter weather for this part of the country. Scattered low clouds at 600 feet, overcast at 1,200 feet with tops at 15,000 feet (pilot reports). Winds

from the southeast, light and surface temperature from 1° to 3° C. ATIS was available on 127.55 .

METAR : LGTS 171850Z 12005 KT 6000E - SN SCT006 OVC 012 01/00 Q1035 NOSIG

METAR : LGTS 171920Z 12005 KT 6000E - SN SCT006 OVC 012 01/00 Q1035 NOSIG

TAF : (171601) LGTS 11010 KT 8000 SCT010 OVC 020 TEMPO 5000 RASN PROB 30 TEMPO 2500 SN SCT 005 OVC 015

UPPER WINDS :	**Flight Level**	**LGTS**
	100 FL	300015-08
	050 FL	12005-03

Pilots reported moderate to severe icing at 3,500 feet.

1.7.2. Weather at the accident site

The weather at the accident site was similar to the weather at Makedonia Airport with cloud layers up to 15,000 feet and snow.

1.8. Aids to Navigation

The following radio aids to navigation were available at Makedonia Airport:

1.8.1

- NDB	THS	345	40 35 37N	22 56 54E	Flight checked 20-4-97
- VOR/TAC	TSL	112.1	40 27 22N	22 59 21E	Flight checked 20-4-97 / 2-1-98
- VOR/DME	MKR	110.8	40 31 11N	22 58 14E	Flight checked 08-12-97 / 2-1-98
- ILS	I-TSL	110.3	40 30 30N	22 58 32E	Flight checked 08-12-97 / 2-1-98
- GP-DME			40 31 30N	22 58 08E	
- OM		75	40 35 37N	22 56 54E	
- MM		75	40 32 25N	22 57 55E	

1.8.2. There is no Terminal Approach Radar (TAR) at Makedonia Airport.

1.8.3. All radio aids were working satisfactorily at the time of the accident.

1.8.4. Makedonia Airport has two runways :

1.8.4.1. RWY 10-28, true bearing 104/284, 2440 x 50 m, LCN 80, asphalt.

1.8.4.2. RWY 16-34, true bearing 166/344, 2440 x 60 m, LCN 45, asphalt.

1.8.4.3. ILS Cat I on RWY 16.

1.8.4.4. Approach lights on RWY16 operating every second lamp.

1.8.4.5. Threshold, end, and edge lights, on all runways were operating normally.

1.8.4.6. PAPI lights on RWY 16-34.

1.8.4.7. ILS course width : 5.5°.

1.8.4.8. ILS glide path angle : 3.0°.

1.8.4.9. Magnetic variation in the airport area : 2° East.

1.8.5. Due to adverse weather conditions the necessary calibration check (after accident) was not performed the day following the accident. The check was performed on 2.1.98. Witness statements from captains flying on the accident night and at approximately the same time, were obtained. The captains reported that all radio aids were operating satisfactorily (Appendix 42). An assessment flight was performed on 19.12.97 during which all radio aids involved were tested. No irregularity was reported.

1.9. Aerodrome Information

1.9.1. Airport co-ordinates

40.31.10 N , 22.58.25 E (intersection of main runways)

1.9.2. Makedonia Airport (LGTS) is extended on the eastern side of the gulf of Thessaloniki, Hellas. The airport elevation is 22 feet.

1.9.3. The airport operates two runways : 16-34 and 10-28.

1.9.4. At the time of the accident the airport control tower was operating 24 hours a day, controlling departing and arriving traffic to runway 16 in use. Runway 16 had an instrument landing system (ILS) Cat. I in full operation available (Threshold elevation 13 feet).

1.9.5. No NOTAMS affecting the airport operation were valid.

1.9.6. Radio navigation facilities are described, in detail, in Par. 1.8 of this report.

1.9.7. A Hellenic Air Force Combat Wing is co-located at the airport and a GCA[12] facility operates during the time of military flights. This facility is on a stand by basis (30'), when there are no military flights. On the night of December 17, 1997, there were no Air Force Combat Wing flights.

1.10. Communications

1.10.1. Communications between ATC and the flight crew were conducted in English.

1.10.2. Communications on the flight deck were conducted in Russian.

1.10.3. Communications between ATC and Hellenic aircraft in the area were conducted mostly in English, except for certain interventions in Hellenic language.

1.10.4. Fixed service communication were considered as satisfactory.

(12) GCA = Ground Controlled Approach

1.11. Flight Recorders

Four (4) flight recorder containers, three (3) of cylindrical shape covered with orange colored fireproof material (asbestos) and a smaller flat container of hard clear plastic material, were recovered at the accident site.

There was no evidence of structural or fire damage to none of them, at least as far as the recording mechanism and medium are concerned, despite the fact that the aircraft parts in which they were installed were destroyed by the impact.

1.11.1. Flight Data Recorder

The MSRP-64-2 Flight Data Recorder Ser. Nº 50171, was designed for magnetic tape recording of the main flight parameters, 40 of them expressed in digital mode and 58 in discrete mode.

Recorded parameters included: pressure altitude, radar altitude, magnetic heading, indicated air speed, pitch attitude, roll attitude, engines and APU status, navigation mode, autopilot parameters, ground proximity warning alerts and parameters indicating flight control position and flight segment configuration.

The data were recorded on a continuous cycle in which the last 25 hours of flight were depicted. The MSRP FDR is started automatically when the three engines gain idling speed and is switched off upon de-energizing the aircraft mains or automatically in case of violent belly contact with the ground.

1.11.2. Cockpit Voice Recorder

The MARS-BM Flight Compartment Voice Recorder Ser. Nº 328022, provided for magnetic tape recording of voice communications between the crew members, between crew members and ATC controllers and coded time reference for synchronization of recorded voice information with the flight data recorded by the FDR.

The third orange colored MARS container (Ser. Nº 16069) was a spare CVR, as officials of the operating company stated. The flat, smaller recorder constituted a Test Set belonging to the aircraft's Airborne Monitoring Systems, according to YAK-42 INFORMATION DATA Document.

All recorders were brought to the German Flight Accident Investigation Laboratory (FUS) in BRAUNSCHWEIG for independent read out. The opening of all recorder containers was documented (homologated) by video recording by FUS officials, in the presence of the Hellenic Investigation Board delegates.

A copy of the FDR tape and CVR tape was handed over to the accredited representatives of Ukraine and Russia as the State of Registry, the State of Operator and the State of Design / Manufacture, respectively.

1.12. Wreckage and Impact Information

1.12.1. Impact area

The area of impact is located in Katerini district at a distance of 37 n.m. SW from Makedonia Airport. There is a slope up to 40% covered by trees,

which reach up to 10-12 meters and the elevation is 3,300 feet (MSL), on the side of a mountain ridge with a top of 4,100 feet. The co-ordinates are N 40° 13' 33" - E 22° 15' 03". The surrounding area is formed by mountainous terrain with numerous ridges. Heavy snowfall the days before the accident, during the day of the accident, and the day after, covered the site with snow up to 1 meter. The area was covered with dense fog up to 4,500 feet.

The aircraft approached the area from SE, on a slight right turn, on a heading of 290° initially and at an altitude of 3,300 feet, between the mountain slopes which converge to the north. After the GPWS warning (CVR 19:12':33") the flight crew tried to gain altitude. The aircraft initially struck trees with a bank of 20° and a nose up attitude of approximately 15°-20°. The investigation revealed that the aircraft was structurally intact at the point of first impact and under controlled flight.

The right wing hit, initially, the tree tops which were cut at a height of 10 meters from the ground. In the sequel, the fuselage hit the trees which were cut at a height of 6, 4, and 1 meter from the ground. The last trees were flattened and uprooted. Finally, the aircraft struck the ground at a distance of 100 meters from the first contact with the tree tops. Following the impact the lower part of the fuselage disintegrated, while the upper part together with the left wing and a part of the right wing bounced and continued in the same direction, crossing diagonally a small rural road. After covering 70 meters, the preponderance of the wreckage struck the opposite side of the small road. At this point the terrain forms a slope of 60% uphill. Continuing to move, the wreckage turned 180° around its lateral axis, moved for another 30 meters with a slight bank to the left and, stopped half inverted with the leading edge of the wings towards the direction of its initial path, at the turn of the road.

From the initial point of sweeping over the treetops, to the final resting place of the main wreckage, there is a distance of 200 meters which forms a corridor of 15 meters width, which is widening to 25 meters at the point of the final stop of the main wreckage.

1.12.2. Debris

After the initial contact of the right wing with the treetops, and for the following 100 meters, until the impact with the ground, the aircraft chopped tree trunks in diameter of 25 to 35 centimeters. The forward part of the fuselage struck first on that phase and a part of the right wing was separated. The cockpit disintegrated at this point. In this area 3/4 of the right wing, part of the forward lower part of the fuselage, the RADOM, the control column, several cockpit instruments and the body of the co-pilot were found.

The recovered flight and navigation instruments sustained severe impact damage to such a degree that testing was not possible. However, some indications "stuck" during impact, have been confirmed by their corresponding FDR parameter readings, such as 290° heading (one of both severely damaged HSIs[12]), 20° right bank and 12° to 15° nose up (both severely damaged Flight Directors) and 0.347 MACH (both Airspeed Indicators). Given the FDR and CVR readings, the opinion can be justified that, all cockpit instruments, excluding the captain's HSI (because of Nº 1 VOR receiver malfunction) were working normally. Further on, parts of the fuselage and the lower part of the passenger cabin were located. At a distance of 40 meters from the initial point of impact, the empennage was found.

(12) HSI = Horizontal Situation Indicator

Located to the left, where the wreckage bounced, were the right engine, the APU, the middle engine, the rear portion of the fuselage, the air conditioning pack and the left engine. All engines were examined on site. The right and left engines showed ingestion of ground and foliage as far aft as the inlet guide vanes to the intermediate compressor section. There was substantial bending of fan blades. No engine showed evidence of fire damage.

Due to the slope of the surface, all 3 engines and the APU[13] ended on the lower part at the foot of the ridge. The rear part of the fuselage which was completely destroyed, rested halfway along the wreckage path. In the area of the final rest of the preponderance of the wreckage, the left wing, portion of the fuselage, part of the right wing and the 3 gears of the landing gear were found.

Most of the bodies of the occupants were located in the area between the point of the first impact and across the path towards the final resting place of the wreckage. The wreckage evidence indicated that both flaps and landing gear were in the retracted position, at the time of impact, (in confirmation to the FDR parameter readings).

1.13. Medical and Pathological Information

1.13.1. The body of the instructor pilot, the co-pilot and the flight engineer were recovered on the first day. The cause of death of each was determined to be dismemberment by blunt trauma.

(13) APU = Auxiliary Power Unit

1.13.2. Specimens from the bodies were obtained by the Coroner Service in accordance with national and international rules (ICAO Manual of Aviation Medicine Doc. 8984 and ICAO Manual of Aircraft Accident Investigation Doc. 6920). All samples were found to be clear of alcohol and drugs.

1.13.3. The body of the captain was not identified.

1.14. Fire

1.14.1. There was no evidence of pre-impact fire or explosion.

1.14.2. There was limited post-impact fire, where the wreckage came to rest. Given that the area was covered with snow, the fire lasted for a short time but with extreme intensity. The fire developed in the area of the central fuel tank between the two wings, covering an area of approximately 8 square meters. The nose wheel, as well as part of the center, fuel tank, were completely burned.

1.15. Survival Factors

The last communication of AEW-241 with Makedonia ATC was at 19:12':28". There was no reply when ATC called at 19:12':51", 19:12':53", 19:13':12" and later.

In accordance to existing national regulation and ICAO DOC 4444, ANNEX 11 "ALERTING SERVICE", ATC informed all authorities related to search and rescue by 19:18':00".

The first indications for the possible location of the accident were obtained by listening to the communication extract between ATC and the flight crew, by whose text, in accordance with the flight crew reports, the aircraft should have been located north of the airport. The flight path of the aircraft which was obtained from PALLAS radar system of the Hellenic CAA as well as from the Hellenic Air Force, showed that the aircraft headed first to the west and later to the southwest of Makedonia Airport. Consequently, all search was directed to the southwest of the airport in the Katerini area and more specifically in the vicinity of Pieria mountains.

Search operation started at 21:00' hours, on December 17, 1997, when the first C-130 aircraft started dropping illumination flares on the shoreline of Katerini, while boats from the Coast Guard were searching along Thermaikos Gulf and the coastal area of Katerini. Air Search and Rescue was performed by C-130, RF-4, and F-16 Hellenic Air Force aircraft, as well as by helicopters from the Hellenic Air Force, the Hellenic Army units and the Hellenic Navy. A total of 167 sorties and 377 hours were flown in the Search and Rescue operation. The Hellenic Army participated with a total of 5000 men (3rd Army Corps). The Hellenic Police, the Special Disaster Intervention Unit (EMAK), mountain climbers and ski clubs and volunteers from the local communities, participated in this unprecedented search and rescue operation.

Weather conditions in the area were extremely adverse, rendering the Search and Rescue operation, virtually impossible. Dense fog up to 4,500 feet, covering the area until 20.12.97, made low flights impossible as well as the approach of the helicopters there, in order to locate the wreckage of the aircraft.

It was virtually impossible for the search teams to move into the mountain area, due to fog and thick forest which was covered with snow more than one meter deep.

The YAK-42 aircraft was not equipped with an Emergency Locator Transmitter (ELT), so it could not be located electronically. Satellite spotting was unsuccessful. On December 20, 1997 the fog settled to 2,500 feet and at 08:04' a Hellenic Navy helicopter sighted an area on the lower part of the ridge, called "Five Towers" of the Pieria mountains, where the tree tops were cut.

The accident site was located and a crew member of the helicopter managed to descend to the scene with a rope. This was the first contact with the lost aircraft.

The magnitude, the force of the impact, and the total destruction of the aircraft indicated that the accident was not survivable. All injuries were consistent with deceleration trauma of different intensity, related to the passengers seat location and the aircraft breakdown pattern. Evaluation of individual injuries by seat assignment was not possible, due to the wide spread of the debris of the passenger cabin. Seats were torn and scattered and seat belts were broken apart from their individual seat structure, due to the force of the impact.

The greatest number of bodies was spread along the path, from the initial impact of the aircraft with the ground, when the lower part of the fuselage disintegrated, up to the final resting place of the preponderant wreckage, 70 meters to the north. The Board of investigation arrived at the

accident site at 12:30' UTC on December 20, 1997. The accident area was immediately roped off, and placed under the guard of the Hellenic Army.

After a general survey of the site, the Board released the bodies and ordered the Rescue teams to commence their removal and transportation to the morgue in Thessaloniki. Considering the adverse conditions involved (weather, terrain), all services engaged in Search and Rescue, performed their duties in an outstanding manner.

In the following days, the Board visited the accident site eleven times, in order to locate evidence and obtain the necessary material for the investigation.

1.16. Test and Research

Examinations, studies and testing were conducted, regarding, human performance, recreation of the flight path, electronic interference for the eventual existence of spurious radio signals, impact forces involved and terrain avoidance procedures, among which:

1.16.1. Mathematical calculations

Impact Forces

1.16.2. Study on the effect of electromagnetic interference on YAK-42 aircraft, December 17, 1997.

1.16.3. Animation - Reconstruction of the flight.

was produced by LBA - Germany

1.16.4. Human factors analysis and Group Dynamics

YAK-42 aircraft accident (CFIT).

1.16.5. Flight Data Recorder and Cockpit Voice Recorder Decoding

"Accident investigation office of the LBA"

1.16.6. FDR - CVR decoding

Interstate Aviation Committee(of Russia)

1.16.7. Airborne Flight Path recreation by Helicopter

Makedonia Airport - Thessaloniki - Greece

1.16.8. Simulated recreation of the Flight Path

The segment of the flight following the missed approach was reproduced on a B-737 simulator, during which various VHF/NAV failures were staged, in order to form a visual impression of instrument and radio facility indications, based on the cockpit conversation (CVR) of the AEW-241 crew members.

1.16.9. Simulated recreation of the Flight Path

Yak-42 simulator , Kiev, Ukraine

1.16.10. Instrument examination (recovered from wreckage)

In an attempt to reproduce the selected DME frequency before the accident moment, both DME frequency selectors on the additional panel were delivered to the Technology and Research Center of the Hellenic Air Force. Details of the job accomplished are in Appendix 37-A exhibited. Among the results, the very probable situation, based on several experiments carried out with similar light bulbs, was that during impact, the light bulb electrical circuit was not under power.

It is considered as very important and necessary to report at this place, in conjunction with the above, that the small additional panel (DME frequencies selection) on the YAK-42 simulator, during the recreation of the flight path in Kiev, was also inoperative.

1.17. Organizational and Management Information

1.17.1. "AEROSWEET AIRLINES" was registered under the Ukrainian legislation on March 25, 1994 (certificate N^{o} 4942) and re-registered in April 17, 1997 (certificate N^{o} 05432). The company has a valid AIR OPERATION CERTIFICATE issued on July 13, 1994. It operates two B-737-200 aircraft, and its program covers domestic and international navigation in accordance with the international and Civil Aviation Rules of Ukraine.

AEROSWEET AIRLINES is a member of IATA since October 23, 1996. The company had hired, by "wet" leasing, a YAK-42 aircraft from Lviv State Aviation Enterprise for domestic and international routes, in accordance with agreement N^{o} 07-001-N249 dated March 6, 1997.

The specific aircraft type YAK-42, UR-42334 was transferred first from Aeroflot to Air Ukraine in 1992 and was re-registered in 1993. Air Ukraine transferred the aircraft to Lviv State Aviation Enterprise, an associated company, in 1996.

The aircraft was wet leased to AEROSWEET AIRWAYS in December 1997. Leasing Agreement N^{o} 07-001-N249 - 6.3.97, refers to insurance concerning aircraft, crew, passengers and third parties.

1.17.2. There is a bilateral agreement between the Hellenic and the Ukrainian State, for granting of a temporary permit to AEROSWEET AIRWAYS, in order to perform a number of flights from Kiev and Odessa to Athens and Thessaloniki, on a weekly basis, between 25.10.97 and 28.3.98 (signed October 29, 1997).

Following the above, Olympic Airways has signed a BLOCKED SPACE AGREEMENT with AEROSWEET AIRWAYS for the realization of the above flights. Article 4 of this agreement is stressing that :

> "1. The aircraft shall be supplied by V.V. (AEROSWEET AIRWAYS) in an airworthy and operational condition, duly manned and equipped for the operation of the services. It shall remain under V.V. technical and operational control and shall be operated in accordance with V.V. operational requirements . . .".

1.17.3. By reviewing both the Organizational diagrams of Lviv State Aviation Enterprise and AEROSWEET AIRWAYS, Flight Safety Departments were located, on a top managerial level.

1.17.4. The Board of investigation was informed that on January 15, 1998, by Presidential Decree referring to "Urgent Measures for Providing Flight Safety for Ukrainian Aviation" among other measures, the following items are stated:

" - That the Cabinet of Minister of Ukraine must within four months :

- Solve the question of setting up regional flight safety control and supervision departments within the State Aviation Administration of Ukraine.

- That the Ministry of Transport of Ukraine must :

- Within a month implement new certification rules for users and companies providing, maintenance and repairs of aviation technology, intending to terminate the license certificates of the users and companies not having their own infrastructure and personnel, guaranteeing airworthiness of aviation technology, and also to introduce more rigorous requirements for the users carrying out international flights.

- In the first quarter of 1998 arrange the inspection of all the Ukrainian users and companies, providing aviation technology maintenance and repairs, in order to evaluate their ability to ensure airworthiness of the above mentioned aviation

technology as well as the state of the technical means of air navigation service, and the way they are operated.

• The State Aviation Administration of Ukraine must organize the registration of insurance companies which provide mandatory aviation insurance and establish regular control over such type of insurance."

1.18. Additional Information

1.18.1. Air Traffic Control

Upon entering Hellenic airspace on December 17, 1997, AEW-241 was under Makedonia Control and next was transferred to Makedonia Approach. Radar coverage and radar services were not available, since Makedonia Airport is a non radar facility.

Hellenic A.T. Controllers operate under national rules which are in accordance with ICAO ANNEX 11 "AIR TRAFFIC SERVICES" and ICAO Doc 4444 - RAC1501 "RULES OF THE AIR AND AIR TRAFFIC SERVICES".

1.18.2. Air Traffic Controllers

The ATC shift at the time of flight AEW-241 was consisted by :

1.18.2.1. Supervisor

Male 50 years of age

HCAA License number and date : 613/18-6-80

Ratings : Approach, Tower

Medical certificate : Valid to 11-6-98

Family status : Married, two children

1.18.2.2. Approach Controller

Male 37 years of age

HCAA License number and date : 987/24-1-90

Ratings : Approach, Tower

Medical certificate : Valid to 11-11-98

Family status : Engaged to be married

1.18.2.3. Tower Controller

Male 29 years of age

HCAA License number and date : 1132/5-10-93

Ratings : Tower

Medical certificate : Valid to 11-05-98

Family status : Single

All the above were certified by the Hellenic CAA to perform their specific duties. With respect to formality, the award of the "Makedonia" Airport Tower Rating to the Tower Controller was pending, since he had passed the examination on 12-12-97, his score being 80%, and the rating award was

done on 22-12-97. Throughout the AEW-241 flight, Makedonia Approach and Tower Control handled the following flights at various times :

AEW-241 18:55':19" - 19:12':50" (ARR)
OA 914 18:40':23" - 18:41':17" (ARR)
OA 871 18:55':37" - 18:57':41" (ARR)
OA 246 18:51':11" - 18:55':10" (ARR)
CUS 211 19:01':22" - (DEP)
AGJ 2705 19:02':44" - (DEP)

2. ANALYSIS

2.1. General

The Board of investigation examined flight crew actions to determine how it was possible for a four member certified crew to allow the aircraft to deviate from course and crash into an area of mountainous terrain.

The Board examined the actions of Makedonia ATC to determine what role, if any, it may have had upon the accident. All other parameters which could possibly be involved in the accident were also thoroughly investigated, such as radio aids on the ground, on board navigation equipment, and survivability issues to determine the extent to which injuries and fatalities could have been reduced. Electronic interference by ground stations (communications, TV, telephony etc) was also a subject which was examined by a University Committee. Human Factors analysis was carried out by a specialist psychologist. Extensive decoding and analysis of the CVR and the

FDR was performed by the assistance of the German Flight Accident Investigation Laboratory (FUS) in Braunschweig and the Russian Interstate Aviation Committee (MAC), Moscow.

There is evidence that there was a malfunction on VHF/NAV Nº 1, and the aircraft was dispatched from Odessa with Nº 1 VHF/NAV set inoperative. There was no evidence of any other failure or malfunction in the aircraft, its components, or its systems.

Weather conditions over Makedonia Airport, as well as in the vicinity of the airport, were IMC. However the cloud base was well above the airport approach minima.

According to documents obtained, all four crew members were properly certified to operate the YAK-42 aircraft with current English radiotelephony certificates valid. Specific details of the training and personal profiles of the accident flight crew were not made available to the accident investigation team.

2.2. Human Performance

The crew had no previous experience flying into Makedonia Airport and there is no evidence that they had a familiarization demonstration on any training device. (ICAO ANNEX 6, chapter 9.4.3, 9.4.3.2, 9.4.3.5).

The evidence indicated that AEW-241, upon entering Hellenic airspace (18:40':09") received from Makedonia Control clearance to proceed to LAMBI intersection and descend to FL 100.

The aircraft was given a clearance limit to the North Holding for a LAMBI 1F arrival and VOR-DME-ILS approach to runway 16.

The LAMBI 1F arrival routes an incoming aircraft to an "arc" 19 n.m. DME from TSL VOR with a left turn towards the localizer for ILS runway 16 (see Appendix 4 and Appendix 5).

There was no evidence from the CVR decoding that a flight crew approach briefing took place, due to the limited (30minutes) duration of the magnetic tape.

The crew did not follow normal procedures by requesting for weather information or by announcing to the controller that they had the ATIS information, as provisioned.

At 18:47':24" and 18:49':41" there were two warnings from the GPWS of the aircraft. No action was taken by the flight crew.

The aircraft did not follow the "arc", as instructed by ATC, but proceeded instead towards THS/NDB. There is evidence, by FDR, that AEW-241 was never established on the localizer, nor did it pass over the outer Marker.

From 18:51':56" ("***AEW Number One***") until 18:54':02", the flight crew did not give a position report as it was instructed by the ATC ("***Report outer Marker***").

At 18:54':02" they had arrived over MAKEDONIA Airport without knowing it, asking the air traffic controller for heading.

That same time the controller saw the aircraft passing over the end of RWY 16 and instructed them to climb to 6,000 feet and remain in the South Holding Pattern.

From the CVR and ATC communications transcripts, it is observed that the captain instead of executing ATC instructions, that is to turn right on a north bound course and report TSL/VOR, and inspite of the suggestions from the other crew members (co-pilot: 18:58':43" "***To turn right***") and (pilot instructor : 18:59':13" "***Go ahead to the VOR, go to the VOR, to the VOR***") he turned towards a westerly heading and this heading, with some minor variations, was maintained until the impact at 19:12':43".

The flight crew failed to properly utilize all the available, on the ground and in the cockpit, radio-navigation aids / equipment. Most of the time they were preoccupied with tuning and interpreting the navigation instruments in the cockpit.

Several times the flight crew were more concerned about ADF tuning / readouts than the TSL/VOR information, on which the missed approach procedure is based.

They quite often changed their focus from one source of navigational information (VOR) to the other (ADF). This, in conjunction with Nº 1 VOR malfunction, contributed significantly to the confusion in the cockpit and to the disorientation of the flight crew.

Even though they were disorientated (#60, 19:03':26")
MAK/APP : "***AEW-241 are you North of TSL, confirm ?***"

AEW-241: "*Yes North, TSL*", CVR #64, 19:06':12" Captain : "*Stop. I don't understand what have you taken. Which heading we 're passing*", CVR #68, 19:10':50" Captain : "*So Lyosha let's orient ourselves ... etc*") they continued to respond to the controller's repeated requests about their position, their flight path and their ability to comply with depicted approach procedure, without reporting (expressing) the difficulties they were facing. The flight crew did not declare an emergency.

By a false interpretation of the instrument indications in the cockpit of selected radio-navigational aids, the flight crew was flying towards the west, for over ten minutes.

It is not known whether the crew thought that they were maneuvering to directly intercept and establish themselves on radial 344 outbound from TSL/VOR, in order to enter the North Holding and be able to execute a second ILS approach.

Although Jeppesen approach charts were found in the wreckage area, it could not be determined, from the available evidence, what navigational charts the crew had readily available and used during the approach, since :

- At 18:54':10", when the flight missed the runway, the crew requested "Heading". The Jeppesen approach chart 11-1 for VOR/ILS for runway 16, clearly defines that for a missed approach the procedure is to "climb straight ahead to 2000 then turn right and proceed to the holding, climbing to 3,500". Should the flight crew have had available and studied the aforementioned approach chart, the captain would not have been required to request a "Heading".

- At 18:54':45" the captain asked "***Tolya, take a look at second, this one, the chart for go around***".

- At 19:09':55" ∃ "***Have you got an approach to runway 16 ?***".

- At 19:11':00" ∃ "***Look at the chart***".

The above 4 statements are of conflicting nature. No clear picture on the availability of the proper Jeppesen charts, can be formed.

The crew failed to respond to the last two GPWS warnings (19:12':08" and 19:12':32") to react immediately and in accordance with the FLIGHT MANUAL's operational provisions to such an emergency situation. The captain did not achieve **maximum performance climb** in response to the GPWS alert signals (audio and visual) just prior to impact.

2.3. Situational Awareness

Situational awareness, in the aeronautical piloting sense, means that a flight crew is aware of the aircraft's position in time and space, relative to the geographical terrain over which they are flying, the capabilities of the aircraft and its systems and the state of the crew members themselves (e.g. ability to conduct certain maneuvers and to satisfactorily utilize all the equipment systems in the aircraft).

The CVR transcript indicated that once the flight crew initiated the missed approach procedure, situational awareness was never achieved by the crew.

The flight crew was disoriented as to the location of the aircraft in time and space, and to the proximity of mountainous terrain. The flight crew exhibited confusion as to radio-navigation aid, settings and data presentation.

The contribution of the instructor pilot to the overall crew functioning in the cockpit appeared to be confusing and not very helpful most of the time.

Critical segments describing the situation in the cockpit are :

- At 18:59':19" the captain, in spite of the co-pilot's suggestion "***To the right***" and instructor pilot's "***Go ahead to the VOR, go to the VOR***" decided urging in respect of the flight path : "***Well we should (turn) to the left then***", and turned the aircraft towards a westerly heading.

- At 19:02':27" MAK/APP asked AEW-241 for confirmation "***You are 10 DME outbound TSL to the north ?***", and the flight crew replied "***Confirm***". However, the FDR indicated that the flight was at this time on westbound course, heading 270° , approximately 10 NM southwest of TSL.

- At 19:03':26" MAK/APP asked AEW-241 again to confirm if they were north of TSL/VOR and the flight crew responded "***Yes North TSL***". The aircraft's actual position at that moment was still west-southwest of TSL/VOR, on a westbound course.

- At 19:05':07" the captain asked the instructor pilot "***Tell him ... ask him for vectoring***" and the instructor pilot, as well as the co-pilot, were concentrating on whether the ADFs / Locators were in operation or not, and what frequency each ADF set was tuned to.

• At 19:06':12" the captain openly stated : "***Stop. I don't understand what have you taken ? which heading we're passing ?***" and a few seconds later "***Ask for vectoring***".

• At 19:07':50" the flight asked MAK/APP for radar vectors. MAK/APP replied that "***There is no radar vectoring ... etc***" and further instructed them to "***Comply with VOR-DME-ILS approach Rwy 16***" to which AEW-241 affirmed, as well as to "***Report on the LLZ***". This exchange with ATC was followed by confusion in the cockpit, with the instructor pilot distracting the other flight crew members, with discussion of problems in navigating, operating the navigation equipment, determining what track they were on, etc.

2.4. Terrain Awareness

There is evidence that in addition to deficiencies related to situational awareness, serious lack of terrain awareness was present as well, in the cockpit of AEW-241. The relevant indications in this specific case, were the following:

• The flight crew had no previous experience of the mountainous terrain surrounding Makedonia Airport since none of them had flown into Makedonia Airport before. Furthermore, darkness and IMC conditions limited the flight crew's ability to become aware of the terrain.

• The captain's decision not to follow the "arc" of LAMBI 1F arrival, as called for by the arrival procedure and instructed by ATC but

proceeding instead from LAMBI direct to THS/NDB, is a clear indication of flight crew ignorance of the mountainous terrain they were flying over. As a result of this deviation, the GPWS alerted twice (at 18:47':24" and at 18:49':41"). So those two alarms were, most probably, due to the proximity with the high ground of the north-northwest part of mountain Hortiatis ridges (see Appendix 3).

• At 19:09':17" when the instructor pilot instructed the captain to turn towards the VOR ("***Come on to the VOR, to VOR***"), the captain asked for confirmation "***Well what ? With left turn ?***" which was actually the right decision for a turn away from the mountainousarea, and the instructor pilot, being unaware of the terrain, responded: "***But no, on mountains ?***".

• The same happened a little while later at 19:09':26" when the co-pilot said : "***We should turn to the left***", which in fact was a turn away from the mountains and the shortest way to the assigned VOR, but the rest of the crew unfortunately ignored him.

2.4.1. Ground Proximity Warning System (GPWS)

The GPWS incorporates a vertical speed computer, an analog computer and serves for warning the crew members of dangerous ground proximity by audio and lighting means of the form "GROUND PROXIMITY".

The output signals are issued in the following dangerous conditions :

- During take off, when the radio altitude is within 50 and 250 meters, the Landing Gear (L.G.) is retracted and the vertical speed of descent exceeds 1.6 m/sec.

- During descent, while the radio altitude is within the range of 250-50 meters and the L.G. is retracted.

- During descent, with the radio altitude within the range of 600-50 meters, provided programmed limitations of the vertical speed are exceeded. In all cases the sound of the warning signal is identical.

The terrain warning sounded a total of four (4) times : at 18:47':24" for four (4) seconds, at 18:49':41" for four (4) seconds, at 19:12':08" for four (4) seconds and at 19:12':32" for eleven (11) seconds. The reasons for the first and second warnings could not be determined with certainty. According to the FDR data, the recorded radio altitude was on the boundary of the alert limit, and there was no descent, during the first alert. During the first alert, the CVR recorded a comment about mountains, supporting the opinion as stated in paragraph (2.4). The third and fourth alarm were activated because the aircraft was flying towards the mountainous terrain and the radio altitude was rapidly decreasing.

The warning at 19:12':08" (third alert), passed without reaction from the flight crew. They should have conformed with the FLIGHT MANUAL instructions "Aircraft Crew actions when TERRAIN CLOSURE warning system is operating" (Appendix 27). If they would have applied the proper climb maneuver, they would probably have been able to climb over the mountain. The red light "GROUND PROXIMITY" on the warning annunciator panel came on, during the fourth alert (CVR), and for the first time the necessity to climb was recognized, by the flight crew. The captain, realized the serious situation and initiated a terrain avoidance maneuver, but it was too late.

Instrument meteorological conditions (IMC) and darkness limited the flight crew's ability to become aware of the terrain. The unrecognized reasons for the GPWS warning signals, and the prevailing cockpit management conditions at that time (loss of situational awareness) reduced the ability of the flight crew to recognize and interpret appropriately the seriousness of the situation. The initiation of avoidance action by the flight crew in response to the GPWS alarms is a very serious subject to be further addressed by the international aviation community, taking into account the reliability of the various GPWS systems, the situational awareness of flight crews and their subsequent response.

The flight crew of AEW-241 had four (4) GPWS warnings during their approach and flight in the vicinity of Makedonia Airport. The three first alerts were largely ignored.

2.5. Cockpit Resource Management (CRM)

In accordance to ICAO Circular 217 - AN/132 - Human Factors Digest Nº 2, page 5, CRM training is :

- A comprehensive system for improving crew performance, addressing the entire flight crew population.

- A system that can be extended to all forms of flight crew training.

- Concentrating on crew member attitude and behaviors and their impact on safety.

- An opportunity for individuals to examine their behavior and make individual decisions on how to improve cockpit teamwork.

- Using the flight crew as the unit of training.

The Board examined extensively both the cockpit voice recorder and the ATC transcripts. The lack of a command personality presence in the cockpit is more than evident. Investigating the sequence of events, there is no indication that the flight crew attempted to apply CRM concepts in practice, nor was there any evidence provided that would have indicated that the crew would have received CRM training.

As a result :

- No checklist was performed in the cockpit throughout the last 30 minute period of the flight. The following checklists should have been carried out, in accordance with the YAK-42 aircraft Flight Operations Manual :
  - Before descent checklist.
  - After transition to aerodrome barometric pressure(QNH) checklist.
  - After gear extension checklist.
  - Before entering glideslope checklist.

Although the flight crew articulated misgivings several times during the flight, no pilot (until 19:07':40") recognized that they had lost situational awareness. In general, it can be noted that :

- No one was cognizant of the specific missed approach procedure, even while trying to execute it.

- The flight path was not monitored in relation to the appropriate approach charts.

- No one had a mental image of the procedures to be followed.

AEW-241 impacted terrain while each flight crew member individually was engaged in solving his problem, since they had lost situational and terrain awareness. This situation may have been prevented, if the flight crew had received CRM training, which clearly defines the role of each pilot in a team work concept, in order to ensure, inter alia, situational awareness and proper procedures in accordance with the flight operations manuals, approach charts and the ATC clearances.

This cross cockpit monitoring provides a "fail safe" method of intercepting human errors, which if undetected may eventually interfere with the safe operation of the aircraft.

2.6. Confusion in the Cockpit

It is evident that (for the major part of the 30' minute duration of the CVR transcript) confusion was present in the cockpit of AEW-241. The term "confusion" (NASA / ASRS - L. J. Rosenthal, R. W. Chamberlin, R. D. Matchette, The Ohio State University) "denotes mental fuzziness, a state of perplexity or an inappropriate melding of ideas. Cognitive errors such as misidentifications, misclassifications, simultaneous belief in two inconsistent ideas and errors of substitution are manifestations

of confusion. The idea of disorientation also relates". In the present case it was investigated a broad spectrum of factors related to the mental and psychological conditions of the flight crew following the missed approach at Makedonia Airport, among which the following are mentioned :

- Lack of command presence among the crew members.

- Lack of knowledge, familiarity and experience resulting in loss of situational awareness.

- The major handicap of non availability of the Nº 1 VHF/NAV, resulting subsequent complications in the overall cockpit workload.

- Inadequate knowledge of English.

- The pilots shared misbeliefs and perplexity and most of the time, held different but equally incorrect understandings of the situation and the procedures.

- No crew member declared their difficulties, or an emergency, after they were informed that radar assistance was not available.

2.7. The Makedonia Approach Controller

It was examined the performance of the Makedonia Airport approach controller to determine whether his actions were in accordance with the appropriate ATC procedures. The evidence indicated that he provided clearances in accordance with ICAO rules and requirements, as it is

observed from the communication extract, from 18.55' 58" until 18.56' 32"; maintained separation of the aircraft he was controlling, and sequenced flights efficiently.

The controller was entirely dependent on information provided by the crew related to the positions and the flight parameters of AEW-241, in order to assess whether the aircraft required air traffic services beyond that provided for in the applicable rules and regulations.

In a non radar environment a controller's perception of the progress of a flight, is entirely dependent on his experience and on the quality of the information that the flight crew provides. If this information is inaccurate, this directly causes insufficient input in the controller's awareness of the situation, since he has no other data to crosscheck, relative to the condition of the aircraft and the flight, as experienced with this particular flight. In this case the pilots of AEW-241 did not provide the controller with accurate information and the controller, having his own insufficiencies, concerning the correct assessment of the situation, failed to understand the critical situation the aircraft was in, so as to intervene immediately. The crew of AEW-241 requested additional services from the controller at :

(**From CVR transcript:**)

(a) 18:54':02" "***Say again heading AEW-241***".

(b) 18:54':10" "***Give me please heading***".

(c) 19:07':50" "***Makedonia AEW-241 if possible request vectoring runway 16***".

(d) 19:08':03" "***Request route vector***".

All the above requests indicated that the flight crew was under the impression that they were in radar environment. The flight crew had no previous experience flying into Makedonia Airport, and it appears that they were not familiar with the radio and communication facilities available, as contained in the official AIP Greece. Additionally, they should have noted that there was no radar service available, by the following :

a. On their first contact with Makedonia Control and when they reported "***Squawking 6131***", the Controller did not reply "***radar contact***" or "***identified***" (ICAO DOC 4444-RAC/501, VI, 2.2 and X, 4.1.1), but in the conventional non-radar terminology.

b. There is no "***Radar Vectoring Area***" chart for Makedonia Airport.

c. There is no radar mentioned in the AIP Greece for Makedonia Airport. The AIP clearly indicates that there is a Military Radar Service available in case of emergency and upon request, (TUGRIT Service). Jeppesen inaccurately displays the "(R)" on chart 11-1 for Makedonia Airport, without indicating that this refers to the military "***TUGRIT Service***" and not a TAR(Terminal Area Radar).

The communication between the flight crew and ATC was performed in English, which was used as a universal medium for communication because the national languages of the ATC controllers and the flight crew were Hellenic and Russian respectively. Communications did not appear to be seriously out of the ordinary, during the first part of the approach flight. But as the flight continued, it became increasingly apparent that while both

parties possessed English language capability, neither party appeared to have the fluency in English to move beyond routine exchange of ATC terminology to describe and assimilate the extent of the critical situation that was rapidly developing.

In contradiction to their requests for additional (radar) services, the flight crew at all times expressed confidence in their position, their flight path and their ability to execute the approach procedure that the controller offered them.

It was investigated if the two requests for vectors at 19:07':50" and 19:08':03", may have provided some indications that AEW-241 was experiencing difficulties, so it could have been reasonable for the controller to recognize that the flight crew was facing difficulties. Although the flight crew expressed no difficulties about their ability to follow ATC instructions, the aforementioned requests, may have provided some indications of existing or potential difficulties.

The controller, in his statement was stressing that his opinion of the AEW-241 crew was that their transmissions from the beginning were incomplete, causing him to repeat his instructions and specifically request confirmations. He could not understand why they did not execute his instructions and why they did not inform him of their difficulties. He stated, that he was sure (as were other witnesses in their statements) that AEW-241 was on a northbound track after the missed approach. Analyzing the sequence of events of the communications between the flight crew and the controller, the most critical point was at 19:07':50" when AEW-241 asked

for "***route vectors***" and the controller informed them that : "***We don't, can't afford radar vectoring and to comply with VOR-DME-ILS approach RWY 16***". This was a unique occasion to break the "sequence of events".

At 19:09':38" hours, the aircraft reported " ***position (interruption) two eight miles*** ". The ATC Controller assumed that the aircraft was flying at or around R344 from TSL VOR. This position is well within Thessaloniki TCA which extends up to 38 DME TSL at this direction.

At the same time, the aircraft was also considered safe from ground obstacles, since position 28 DME TSL on radial 344 TSL VOR is within MINIMUM SAFE ALTITUDE provisions (25 DME from MIKRA / VOR, 29 DME from TSL / VOR) and also happens to be within the secondary buffer zone, around published Northern Holding Pattern.

The approach controller was concerned and carefully followed the progress of flight AEW-241. When he answered that there was no radar available, he made, at the same time, the most critical question to the flight crew : "***Are you able to comply with VOR-DME-ILS approach RWY 16 ?***". At this point, he received the most critical answer from the flight crew which was decisive in the formation of his train of thought : "***Confirm***". This answer relieved his concern.

The reasons why the flight crew never declared an emergency, will remain unknown and without logical explanation.

3.0. CONCLUSIONS

3.1. Findings

1. The aircraft was obtained by Aerosweet Services from Lviv State Aviation Enterprise for this scheduled flight.

2. The flight crew was properly certified by the Ukrainian authorities.

3. The flight crew had more than 24 hours of rest before reporting for duty and they were on duty for 8:03' hours before the accident.

4. None from the flight crew had previous experience of operation to Makedonia Airport.

5. The flight was dispatched from Odessa with the Nº 1 VHF/NAV receiver inoperative, which was contrary to the minimum equipment list (MEL).

6. Four additional passengers were on board. They were not listed on the passenger manifest, and were not accounted for in the weight and balance sheet.

7. The weather conditions at Makedonia Airport were above required approach and landing minima, however, darkness and an overcast cloud layer obscured awareness of mountainous terrain in the area.

8. There was no evidence of any crew briefing or the use of checklists in the cockpit of AEW-241 during the descent and approach to Makedonia Airport, since the last 30 minutes have recorded by the CVR.

9. The flight was instructed by MAK/APP to conduct the LAMBI 1F standard arrival (STAR) procedure and was cleared to execute a VOR - DME - ILS approach to runway 16.

10. The aircraft did not follow the "19 DME arc" as required by the "STAR" LAMBI 1F approach, but proceeded directly to THS/NDB.

11. There isn't approach radar available at Makedonia Airport.

The Jeppesen approach chart for the airport, incorrectly indicated that approach control radar was available without specifying that this radar was a military facility and service could be provided upon request in case of emergency. The AIP-Greece clearly defines that Military Radar service is available upon specific request only (TUGRIT SERVICE).

12. The aircraft overshot the localizer course at least twice and the flight crew were unable to establish a stabilized approach.

13. According to the CVR cockpit conversations, the flight crew was confused and uncertain with respect to the navigation aids and the information that was presented.

14. There were no standard callouts made by the flight crew related to the glide slope, outer marker or minima, during the approach.

15. The flight crew was unaware that they overflew the runway until they were informed by the tower that they had passed over the airport.

16. The flight crew initiated a go-around but did not follow the published missed approach procedure, nor did they follow the instructions given by the ATC.

17. Although instructed by ATC to proceed to, and enter the south holding pattern, the flight continued on a flight path to the west.

18. Cockpit conversations recorded on the CVR, indicated that the flight crew remained confused, disorganized, and disoriented during the missed approach and the subsequent clearances issued by the ATC. They had lost situational and terrain awareness, and they were uncertain with respect to the radio navigation aids and the information that was presented. They also requested twice "route vectors" and "heading" although Makedonia Airport is a non-radar facility.

19. The flight crew may have been under the impression that radar was available as indicated inaccurately on the Jeppesen approach chart.

20. The flight crew was cognizant that they were following a westerly course.

21. Most of the time the flight crew was more concerned about ADF tuning / readouts than the TSL/VOR information, on which the missed approach procedure is based.

22. The flight crew occasionally was confused in reading and reporting the correct distances on their DME equipment (miles to kilometers and vice versa). This evidence in conjunction with those para 1.16.10 supports the impression that the source of above reported distance readings was not the appropriate for international flights distance measuring equipment (D.M.E.).

23. The flight crew in their effort to solve the navigational problem, often switched their focusing from VOR/DME information to ADF, and vice versa. This, in conjunction with the Nº 1 VHF/NAV receiver malfunction, contributed greatly to the confusion in the cockpit and to the loss of orientation.

24. The flight crew did not declare an emergency, nor did any of their transmissions indicate that they were unable to comply with the instructions and clearances issued by the ATC.

25. There was no command presence in the cockpit. The instructor pilot contribution to the overall functioning of the flight crew in the cockpit, was negative most of the time.

26. The Air Traffic controllers of Makedonia Airport have acted in accordance with the international provisions contained in Annex 11, and the PANS-RAC (Doc. 4444). Omissions in radio communications were noted. However, they were irrelevant and had no bearing on the chain of events leading to the accident.

27. On initial contact between AEW-241 and Makedonia Control, AEW-241 did not report that they had ATIS information, nor did the controller request confirmation of receipt of the ATIS information.

28. A faulty read back of the QNH (At 18:56':12"), which was not caught by the approach controller, was corrected a few seconds later by the flight crew.

29. The Makedonia Air Traffic Controllers were reliant upon the position reports (faulty most of the time), given by the flight crew, since they were exercising ATC in a non-radar environment.

30. The Makedonia ATC made a lot of effort to help AEW-241, within the frame of existing national and international regulations, but the flight crew did not respond in a way expected of airline pilots. Out of 91 emissions performed by ATC, the 63 or 69.3% were addressed to AEW-241, while 28 or 30.7%, were related to five (5) other aircraft, which were in Makedonia TMA at the same period of time.

31. The flight requested "route vectors" twice (At 18:55':03" and at 19:08':03"), which the approach controller and the supervisor of the shift should interpret that they meant radar service. They both did not evaluate enough the gravity of the situation in the cockpit in order to intervene by their own initiative and offer military radar assistance. That the controller's judgment was restricted considerably by the unexplained insistence of the flight crew, that they were able to comply with ATC instructions and clearances, instead of declaring an emergency.

32. There were detected no failures or malfunctions of the aircraft, its systems or devices prior to impact, except the failure of N^{o} 1 VHF/NAV.

33. The radio navigation aids at Makedonia Airport were functioning properly.

34. There was found no evidence of environmental radiomagnetic interference, with the radio navigation aids or with the aircraft instrumentation.

35. There is no evidence that the installation of the international flight panel in the aircraft was approved by the manufacturer.

36. Several documents related to the continuous airworthiness of the aircraft (e.g. last Maintenance Certificate, aircraft Log Book release copy), were requested by the Investigation Board from the accredited representative of Ukraine, but they have not been provided.
A statement, issued by the Ukrainian accredited representative, in substitution of the above mentioned documents, was provided, the content of which did not reflect facts.

37. Departure procedures, as far as the weight and balance manifest is concerned, had been improperly executed. The investigation revealed a difference between the actual number of passengers on board and the documented one (four additional passengers). However, this is pending to further investigation by the appropriate authorities.

38. It could not be established, how many crew members were present in the cockpit during the accident flight, how many of them were seated, and where they were seated.

39. The captain did not achieve maximum performance climb, in response to the last two (2) GPWS alarms. Had he applied the proper maneuver at the warning at 19:12':08", he would probably have been able to climb over the mountains.

3.2. Causes

1. The failure of the flight crew to adequately plan and execute the approach and missed approach procedure for runway 16 at Makedonia airport.

2. The failure of the flight crew to properly utilize the Makedonia airport radionavigational aids and aircraft radio equipment / instruments and to interpret the information that was presented.

3. The failure of the flight crew to declare an emergency when they lost their orientation following the missed approach, despite numerous cues alerting them for the aforementioned situation.

4. The captain's failure to achieve maximum performance climb in response to the GPWS alarm signal, 30" prior to impact.

5. The lack of command presence, cockpit discipline and resource management which resulted in a disorganized, confused and ultimately disfunctional flight crew.

6. The company's inadequate oversight, over their flight operations, that allowed for and resulted in scheduling one inadequately prepared and marginally qualified flight crew and an aircraft which did not comply with national and international airworthiness regulations (it had not been issued the Type Certificate with the corresponding Amendment for the international flights), to execute a regular passenger flight with N^{o} 1 VHF/NAV receiver inoperative.

3.3.- Contributing Factors

1. The inadequate training provided to the flight crew for cockpit resource management and international flight operations.

2. The dispatch of the aircraft with Nº 1 VHF/NAV receiver, inoperative, despite the restrictions provided in M.E.L. (Appendix 28, pages 14, 16).

3. The assignment of a marginally qualified instructor pilot to this specific flight who disrupted and substantially reduced the coordination and effectiveness of the flight crew.

4. The inaccurate display of the symbol (R) on the Jeppesen Sanderson Inc. chart 11-1, for runway 16, from which the flight crew, most probably, have formed the wrong impression that radar service was available in Makedonia airport.

5. The insufficient evaluation by the Approach Control, under the aforementioned circumstances, of the difficulties encountered by the flight crew in following procedures and clearances, which prevented the Controllers to offer any available assistance, by their own initiative, in order to prevent, probably, the accident.

4.0. RECOMMENDATIONS

4.1. The following recommendations are issued to the Ukrainian State Department of Aviation Transport :

1. Require that all Ukrainian airlines and flight crews be thoroughly briefed in relation to the present accident report.

2. Urge the Ukrainian airlines, to ensure that their flight crews, are thoroughly briefed on the differences they might encounter, during their international flights, related to operational procedures versus their airborne navigational equipment and the overall philosophy of performing flight operations, in Europe.

3. Evaluate the overall operational system of Lviv State Aviation Enterprise and AEROSWEET in reference to :

a. Their Flight Safety Program.

b. Their flight crew training and recurrent training program.

c. Maintenance and Engineering Program.

d. Application of ICAO Rules and Regulations, specifically :

Annex 6 - Operation of Aircraft

9.4.3. Pilot in command, route and airport qualification.

4.2.1.2. Operational certification and supervision.

4.2.5. Checklists.

4.3.1. Flight preparation.

6.1.2. (General) Minimum Equipment List (MEL).

4. Urge the flight crews to upgrade their English ICAO phraseology standards.

5. Develop a compulsory CFIT (Controlled Flight Into Terrain) training program, including simulator exercises, which will be covered in the training and recurrent training syllabus of all airlines, operating in the country. A CFIT assessment should be imperative.

6. Urge all airlines operating in the country, to include in their Flight Safety program :

a. Cockpit Resource Management (CRM) training, of their flight crews.
b. Line Orientated Flight Training (LOFT).

4.2. The following recommendations are issued to the Hellenic Civil Aviation Authority :

1. Require that all Air Traffic Control personnel be thoroughly briefed in relation to the present accident report.

2. Require that all publishing companies producing radio-navigation charts and maps, follow ICAO ANNEXES and regulations, displaying accurately all information, as recorded in AIP Greece.

3. Consider that most of the aircraft accidents which happened in Hellas during the last 50 years were caused primarily under CFIT conditions. The HCAA is urged to develop a compulsory CFIT training program, which will be covered in the training of all airlines. A CFIT assessment should be imperative.

4. Consider that in view of the expected increase in aerial traffic, in the immediate future, in general, and from the eastern countries, as well (the operational procedures of which should conform with international standards), it is urgently necessary that the Hellenic State renders operational the modern technical infrastructure already available, related to radar environment.

5. ATC controllers and airline pilots should adhere strictly to ICAO phraseology on all communication.

4.3.- The following recommendations are addressed to the International Civil Aviation Organization :

1. Consider that a great number of new airlines from eastern Europe have formed a new picture in the air traffic of the European continent. Inspite the fact that a very serious endeavor is exercised from their part, towards their adaptation of the western procedure and practices, in navigation and communications, the transition period will require considerable time, understanding, and efforts from both sides. ICAO is urged to take the initiative and advance this very important task, mainly through its safety oversight programs.

2. Urge the member states of Eastern Europe to raise the standards of knowledge of English which is used as a universal medium of communication, among the pilot and Air Traffic Controller population worldwide. ICAO is the only institution which can influence through its safety oversight programs.

3. Develop a CFIT training program that includes simulator exercises based among others, to the recommendations which were obtained by the CFIT - ICAO study.

4. Urge the member states to encourage their airlines to include on their flight crew training of a simulated terrain avoidance procedure.

5. Urge member states to alert their pilots and air traffic controllers to adhere strictly to ICAO phraseology on all communication.

6. Evaluate the possibility, that member states introduce new charts and maps, related to radio navigation, with terrain portrayal similar to the topographic charts, where colors display high terrain in the vicinity of the airport.

7. Remind to companies publishing radionavigation maps and charts that all information displayed, must be in accordance with ICAO ANNEXES.

8. Investigate the seriousness and reliability of the various GPWS, versus their interpretation by the flight crews and their subsequent reaction. It is believed that at least some of those systems should be modified or replaced by more advanced models which specify the identification of particular danger.

9. Urge manufacturers of aircraft, of the eastern European countries, to examine the installation of a more simplified altitude display system, in the cockpit.

Elliniko, November 11, 1998

THE CHAIRMAN

A. KATSIFAS

SUPREME COURT JUGDE

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COLONEL

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E. MAVROFOROS*

AERONAUTICAL ENGINEER

THE AAIC SECRETARY

I. PAPADOPOULOS

Position of the Hellenic Air-Force Major and Member of the Aircraft Accidents Inquiry Council Mr Spiros Georgopoulos.

I disagree on the statement and interpretation of subparagraph 5, paragraph 3.3, chapter CONCLUSIONS, of the final report of the accident of flight AEW-241, as well as on everything concerns paragraph 2.7, which justifies the performance of the A.T.C. during the accident in question.

I presume that the Approach Control of MAKEDONIA Aerodrome is a CAUSE for not preventing the accident and not a Contributing Factor, since, by the evidence at the disposal of AAIC, it is clear that A.T.C. had formed the sufficient image to characterize the aircraft in question as "LOST AIRCRAFT", according to Doc 4444. The A.T.C. personnel involved, carried out its duties inefficiently, by interpreting the provisioned in the particular chapter according to their belief; as a result they didn't provide to the crew the necessary help under the prevailing conditions, in order the accident to be avoided.

MAJOR(Pilot)
Sp. Georgopoulos

BETTER WORDING OF PARAGRAPH 2.7, FIRST UNIT, AS FOLLOWING:

The performance of the "MAKEDONIA" aerodrome approach controller was investigated in order to assess whether his actions were in accordance with the provisioned A.T.C. procedures or not. It turned up that his clearances were in accordance to the rules and requirements of ICAO.

The case mentioned in the conversation recording read out extract, from 18:55' 58" until 18:56' 32", which has a very small deviation from the ICAO rules, is due to the unexpected development of the air-traffic at the particular moment and had no impact in the chain of events that took place.

EMM. MAVROFOROS

AERONAUTICAL ENGINEER

The translation has been prepared by
the Hellenic Civil Aviation Authority,
Accidents Investigation Section.

ATTENTION

In any differences between the English and the Greek text, the Greek text is valid.