

No. 3

**Airbus A300B2, EP-IBU, accident in the vicinity
of Qeshm Island, Islamic Republic of Iran on
3 July 1988. Report released by ICAO.***

Note: All times in this report are Co-ordinated Universal Time (UTC). Local time in the Islamic Republic of Iran was UTC + 3 hours 30 minutes and in United Arab Emirates UTC + 4 hours.

1. FACTUAL INFORMATION

1.1 History of flight

1.1.1 On 3 July 1988 the Airbus A300B2-203, registration EP-IBU, was scheduled for four sectors of Iran Air scheduled passenger flights as follows:

Flight	Route	Scheduled time (UTC)
IR451	Tehran - Bandar Abbas	0330 - 0520
IR655	Bandar Abbas - Dubai	0620 - 0715
IR654	Dubai - Bandar Abbas	0815 - 0910
IR452	Bandar Abbas - Tehran	1010 - 1200

The crew reported for routine briefing and flight preparation in Tehran 1 hour 30 minutes prior to scheduled departure time. The first sector from Tehran to Bandar Abbas was on a repetitive flight plan. Take-off was at 0342 hours. The flight was uneventful and landed at Bandar Abbas at 0510 hours.

1.1.2 During the stop in Bandar Abbas the crew remained in the aircraft. No discrepancies or comments had been recorded in the Aircraft Technical Flight Log during the first sector, and this was confirmed to ground personnel by the flight crew. A turn-around check was carried out and no maintenance action was required.

1.1.3 A flight plan had been filed in Tehran for the sector from Bandar Abbas to Dubai (IR655). The departure from the terminal at Bandar Abbas was delayed 20 minutes due to an immigration problem involving one passenger. Prior to take-off from Bandar Abbas IR655 was given an enroute clearance to Dubai via the flight planned route A59 and A59W at FL140 following a simulated MOBET 1B departure with SSR mode A code 6760. The flight was instructed to contact Bandar Abbas approach control after take-off.

1.1.4 The flight took off from runway 21 (magnetic bearing 206 degrees) at 0647 hours and climbed straight ahead enroute (A59 magnetic track 203 degrees). Shortly after take-off IR655 contacted the Iran Air office at Bandar Abbas on company frequency 131.8 MHz and passed a departure message with an estimate for Dubai. IR655 contacted Bandar Abbas approach control at 0649:18 and reported climbing out of 3500 ft estimating MOBET at 0652, the FIR boundary (DARAX) at 0658, and Dubai at 0715. Whilst still under the control of Bandar Abbas approach IR655 contacted Tehran ACC (southern sector) on frequency 133.4 MHz and at 0651:04 reported out of FL70 for FL140, estimating the FIR boundary (DARAX) at 0658 and Dubai at 0715. This message was acknowledged by Tehran ACC with

*ICAO Note.— The ICAO fact-finding investigation was not an ICAO Annex 13 investigation.

instructions to report maintaining FL140 and passing DARAX. Tehran ACC also requested IR655 to confirm squawking SSR code 6760 and received an affirmative reply. At 0654:00 IR655 reported to Bandar Abbas approach control passing MOBET out of FL120. Bandar Abbas instructed the flight to contact Tehran ACC which was acknowledged by IR655 at 0654:11. No further communication was received from IR655 by either Bandar Abbas approach control or Tehran ACC, nor was any communication from the flight received by Emirates ACC or Dubai approach control.

1.1.5 At 0654:43 the aircraft was destroyed by two surface-to-air missiles whilst climbing from FL120 to FL140 well within airway A59 south of MOBET, in the vicinity of Qeshm Island.

1.2 Injuries to persons

Injuries	Crew	Passengers	Others
Fatal	16	274	---
Serious	--	---	---
Minor/None	--	---	

1.2.1 Of the 274 passengers 238 were of Iranian nationality, ten were nationals of India, one of Italy, six of Pakistan, thirteen of the United Arab Emirates and six of Yugoslavia. The 274 passengers comprised 209 adults, 57 children and eight infants.

1.2.2 The crew included the pilot, the co-pilot, the flight engineer and thirteen cabin crew members. All sixteen crew members were of Iranian nationality.

1.3 Damage to aircraft

1.3.1 The explosion of two missiles destroyed the aircraft. The tail and one wing broke off in the air. The aircraft impacted the sea and the wreckage sank.

1.4 Other damage

1.4.1 There was no other damage.

1.5 Personnel information

1.5.1 Pilot-in-command

1.5.1.1 The captain, 38 years of age, held an air transport pilot licence issued on 2 May 1983 and valid until 5 August 1988. His rating for Airbus A300

was issued on 21 July 1985. He had also been rated for B737 (co-pilot) on 20 November 1975, B727 (co-pilot) on 10 August 1977, B747 (co-pilot) on 7 August 1979 and B737 (captain) on 2 May 1983. His last medical check was on 7 February 1988 with no waivers. His total flying experience was 7000 hours of which 2057 hours were on Airbus A300. His last proficiency check (simulator) was on 26 April 1988.

1.5.1.2 The captain's duty hours in the seven days prior to 3 July 1988 were 29 hours 30 minutes. His rest period when reporting for duty on 3 July 1988 had been 32 hours. During the ten weeks prior to 3 July 1988 he had flown over the Gulf area three times on the route Tehran - Shiraz - Dubai and return, and four times on the route Tehran - Bandar Abbas - Dubai and return. His previous flight on the route Bandar Abbas - Dubai had been on 30 June 1988.

1.5.2 Co-pilot

1.5.2.1 The co-pilot, 31 years of age, held a commercial pilot licence (with instrument rating) issued on 2 May 1984 and valid until 27 December 1988. His co-pilot rating for Airbus A300 was issued in July 1987. He had also been rated for B737 (co-pilot) in January 1985. His last medical check was on 28 December 1987 with no waivers. His total flying experience was 2200 hours of which 708 hours were on Airbus A300. His last proficiency check including instrument rating (simulator) was in December 1987.

1.5.2.2 The co-pilot's duty hours in the seven days prior to 3 July 1988 were 48 hours 15 minutes. His rest period when reporting for duty on 3 July 1988 had been 14 hours 15 minutes. During the ten weeks prior to 3 July 1988 he had flown over the Gulf area five times on the route Tehran - Shiraz - Dubai and return.

1.5.3 Flight engineer

1.5.3.1 The flight engineer, 33 years of age, held a flight engineer licence issued on 6 February 1985 and valid until 19 December 1988. His rating for Airbus A300 was issued on 14 June 1987. He had also been rated for B737 on 6 February 1985. His last medical check was on 20 December 1987 with no waivers. His total experience as flight engineer was 2800 hours of which 736 hours were on Airbus A300.

1.5.3.2 The flight engineer's duty hours in the seven days prior to 3 July 1988 were 30 hours 35 minutes. His rest period when reporting for duty on 3 July 1988 had been 14 hours 15 minutes. During the ten weeks prior to 3 July 1988 he had flown over the Gulf area four times on the route Tehran - Shiraz - Dubai and return.

1.6 Aircraft information

1.6.1 The aircraft was an Airbus A300B2-203 manufactured by Airbus Industrie in March 1982. The serial number was 186. The aircraft was registered as new in 1982 as EP-IBU in the Islamic Republic of Iran, and was owned and operated by Iran Air.

a) Airframe

Certificate of Airworthiness : Transport category (passenger, cargo, crew training), last renewal 29 April 1988 and valid until 29 April 1989

Maintenance * : Last "C" check 5 June 1988 at 11396 hours
Last "I/L" check 12 May 1987 at 9254 hours

Total flying time : 11497 hours

Maximum mass authorized : 142900 kg

Mass at take-off : 130921 kg

Fuel at take-off : 18000 kg

Centre of gravity range : 18-33%

Centre of gravity at take-off: 23.9%

b) Engines: Two General Dynamics CF6-50-C2

	No. 1 (left)	No. 2 (right)
Serial number	455942	528149
Time since new	7419 hours	8020 hours
Cycles since new	6125	6086
Last "C" check	5 June 1988	5 June 1988
Time since last "C" check	102 hours	102 hours

c) Equipment:

The aircraft was equipped with the following communication and avionics equipment relevant to the occurrence:

		No. 1 serial no.	No. 2 serial no.
VHF	KING KTR 9100A	3759	3989
Transponder	Collins 621A-6	3800	2881
ADF	Collins 51Y-7	6627	3129
VOR	Bendix RVA-33A	1776	1865
DME	Collins 860E-5	1166	7043
Weather radar	Bendix RDR-1F	2554	3681
Radio altimeter	TRT AHV5-011A5	6060	5441
GPWS	Sundstrand 965-0376-070	1722	--

1.7 Meteorological information

1.7.1 At 0600 hours the weather at Bandar Abbas airport was: Wind 180/6 kt, visibility 6 km in haze, surface pressure 997.2 hPa, clouds one okta

*Note: The times between overhaul recommended by the manufacturer are
C - check 4000 hours and I/L - check 16500 hours or 48 months.

stratocumulus at 3500 ft, four okta altocumulus at 10000 ft, temperature 35 degrees C and dew point 26 degrees C.

1.7.2 The weather in the area to the south of Bandar Abbas at 0700 hours was fair to partly cloudy with scattered stratocumulus at 3000 ft, scattered altocumulus at 10000 - 12000 ft and high cirrus. Visibility ranged from 5 to 10 km in haze. The air temperature over adjacent coastal areas was 35 to 38 degrees C and over the sea 28 to 30 degrees C. Surface pressure was 997 hPa.

1.7.3 The approximate wind profile in the area to the south of Bandar Abbas at 0700 hours was: Surface 190/8 kt, 1000 ft 210/8 kt, 2000 ft 290/6 kt, 3000 ft 310/6 kt, 5000 ft 010/6 kt, 7000 ft 020/10 kt, 10000 ft 030/10 kt, 12000 ft 140/5 kt, 14000 ft 090/18 kt and 18000 ft 080/25 kt.

1.7.4 The approximate air temperatures were: 5000 ft +29 degrees C (ISA +23.5), 6400 ft +29 degrees C, possible inversion (ISA +26.6), 10000 ft +18 degrees C (ISA +13.4), 18000 ft -3 degrees C (ISA +18.0).

1.7.5 Low tide at Bandar Abbas was at 0615 hours. In the area to the south of Bandar Abbas at the time of flight IR655 the tidal flow was estimated as 3 kt towards the west.

1.8 Aids to navigation

1.8.1 The following navigational aids were available at Bandar Abbas International Airport:

VORTAC: Identification BND, frequency 113.1 MHz, transmission Channel 78, continuous day and night service, position 27 13 05 N, 056 22 50 E.

NDB: Identification BND, frequency 250 KHz, continuous day and night service, position 27 13 03 N, 056 21 35 E.

1.8.2 There were no reported discrepancies to the navigational aids on 3 July 1988. The Bandar Abbas VORTAC was the subject of a NOTAM (A532 - 21 May 1988) stating that the flight check had expired on 21 May 1988. A flight check was subsequently carried out on 30 July 1988. The VORTAC was found operational with no discrepancies.

1.9 Communications

1.9.1 The radio communications between IR655 and civil ATC units were normal with no indication of difficulties in establishing and maintaining communications.

1.9.2 Bandar Abbas TWR/APP. IR655 was in contact with Bandar Abbas TWR on 118.1 MHz and Bandar Abbas APP on 124.2 MHz. In addition, Bandar Abbas provides for frequencies 121.9 MHz and 121.5 MHz. All communications on these frequencies were recorded.

1.9.3 Iran Air at Bandar Abbas. Shortly after take-off IR655 was in contact with the Iran Air office at Bandar Abbas on company frequency 131.8 MHz.

1.9.4 Tehran ACC. IR655 was also in contact with Tehran ACC on 133.4 MHz through a remote control air-ground (RCAG) facility at Bandar Abbas operated via a microwave link. The RCAG facility coverage was approximately 100 NM. All communications were recorded in Tehran ACC.

1.9.5 Emirates ACC. Communications on 243 MHz from United States warships and between such warships and military aircraft at the time of flight IR655 were recorded in Emirates ACC (Abu Dhabi).

1.9.6 Communications from United States warships. Transcripts and recordings of communications on 121.5 MHz were made available from a United Kingdom warship and United States warships. Also, transcripts and recordings of communications on 243 MHz were made available from United States warships.

1.9.7 Communications between ground stations. Communications related to IR655 took place between Tehran ACC/Bandar Abbas APP, Tehran ACC/Emirates ACC, Tehran ACC/Muscat ACC and Emirates ACC/Dubai APP. All these circuits were operating satisfactorily.

1.9.8 Communications recordings. The recordings available from Bandar Abbas TWR/APP, Tehran ACC and Emirates ACC also contained ATS direct speech circuit communications between Tehran ACC/Emirates ACC and Tehran ACC/Bandar Abbas APP. Thus, the recordings could be synchronized and time referenced although the time signal on the Bandar Abbas recording was unserviceable.

1.10 Aerodrome information

1.10.1 Bandar Abbas International Airport is located 4.5 NM north-east of Bandar Abbas. The geographical co-ordinates for the reference point are 27 13 07 N, 056 22 39 E. Runway 21 is asphalt, 3664 m long, 45 m wide and elevation is 22 ft. The magnetic bearing of runway 21 was 206 degrees.

1.11 Flight recorders

1.11.1 The aircraft was equipped with a digital flight data recorder and a cockpit voice recorder. Neither had been recovered by 16 October 1988.

1.11.2 The flight data recorder was model Sundstrand 573A manufactured by Sundstrand Data Control Inc., part number 981-6009-010, and serial number 2669. It records the following parameters: Gross altitude, fine altitude, computed air speed, Mach number, magnetic heading, pitch attitude, roll attitude, right inboard flap position, leading edge flap extended, leading edge flap in transit, engine pressure ratio, thrust reverser operating, thrust reverser in transit, radio transmission keying, and time (UTC).

1.11.3 The cockpit voice recorder was model A100A manufactured by Fairchild Weston Systems Inc., and serial number 5424. The cockpit voice recorder provides a continuous 30 minute record of all voice communications in the cockpit, the individual crew stations and the public address system.

1.12 Wreckage and impact information

1.12.1 The wreckage had not been located by 16 October 1988. Most of the recovered bodies and floating parts of the aircraft were found at a location of

26 43 N, 056 02 E approximately 40 NM south-west of Bandar Abbas airport in the waters of the Gulf.

1.12.2 The recovered aircraft parts included two slide rafts (Garrett-Air Cruisers Co.), half of the nose cone, ventilation ducting and attached insulation, interior roof trim panels, cabin interior divider, forward left cabin divider, three large pieces of engine cowling of which at least two were from engine no. 2, fire extinguisher bottle from cargo hold fire protection system, frame of a pair of seats, life-jackets, wash basin and structure of stand, sections of overhead baggage lockers of which one bore seat sign no. 27B, part of cabin attendant seat, large sections of five of the flap track housings, several pieces of aerodynamic surfaces from the flaps, all-speed ailerons, low-speed ailerons and spoilers. One of these surfaces carried an identification plate as follows: TYPE OF MATERIAL A300B, FOKKER BV SCHIPHOL, ASSY NO. A 5.79 68400 - 180, SERIAL NO. FS 1189, DATE OF MANUFACTURE 12.8.81.

1.12.3 One of the large pieces of engine cowling showed external damage, some 15 - 20 penetrations, 1 - 10 cm in size and in a horizontal direction in a 45 degree angle from behind. The cowling originated from the aft left side of one of the engines. The penetrations were consistent with missile detonation beneath the aircraft, between the wing and the tail.

1.13 Medical and pathological information

1.13.1 The bodies of the flight crew had not been recovered by 1 October 1988. By early August 1988 the remains of some 192 victims had been recovered. Few of the bodies recovered were complete. Some 180 victims were identified, many based on circumstantial evidence.

1.14 Fire

1.14.1 There was no indication of fire prior to the explosion of the missiles.

1.14.2 There were signs of burns on some of the bodies recovered which could be an indication of fire caused by the explosion of the missiles, or an indication of a surface fire following the impact with water.

1.15 Search and rescue

1.15.1 At 0651:04 hours IR655 reported to Tehran ACC out of FL70 climbing to FL140, estimating the FIR boundary (DARAX) at 0658, and Dubai at 0715. In the absence of any further communications with Tehran ACC, the controller assumed that IR655 had contacted Dubai APP. However, no radio or radar contact was made with the flight by either Emirates ACC or Dubai APP. At 0718 Emirates ACC contacted Tehran ACC and requested the position of IR655. Recognizing that the flight had not arrived at its destination, the controller at Tehran ACC contacted adjacent ATS units for information on the flight. When no further information could be obtained, search and rescue action was initiated, and the assistance of the United Arab Emirates was requested.

1.15.2 Following a report from Tehran ACC at 0800 hours that IR655 was last seen on radar two minutes south of DARAX, search and rescue action was taken by

the Emirates Rescue Co-ordination Centre (RCC). Four aircraft from the United Arab Emirates participated in the search around DARAX, one CASA C-212 aeroplane from Bateen airport (Abu Dhabi), two Bell 212 helicopters from Sharjah and one helicopter from Ras-Al-Khaimah.

1.15.3 Simultaneously, search and rescue efforts were undertaken by the Islamic Republic of Iran Navy (IRIN), the Islamic Revolutionary Guard, the National Iranian Oil Company (NIOC), and the authorities at Bandar Abbas. On the basis of eyewitness reports, a search was carried out between MOBET and DARAX. Bodies and floating parts of the wreckage were located more than 30 NM north of DARAX and Emirates ACC was informed by AFTN at 0925 hours. At about 1030 hours Bandar Abbas authorities took over search and rescue operations, and advised that assistance from the United Arab Emirates was no longer required.

1.16 Additional information

1.16.1 Warships and boats involved

1.16.1.1 It was reported that Iranian boats of the Islamic Revolutionary Guard were involved in surface action with United States warships at the time of the IR655 flight. The Iranian units were reported to have employed small boats of the Boghammar and Boston Whaler types.

1.16.1.2 Details of the Boghammar 13 metre craft given in the 1988/89 edition of Jane's Fighting Ships were as follows: Displacement 5.3 tons, length 12.8 m, main machinery 2 Volvo Penta TAMD 70 E diesels, 610 hp, 2 shafts, maximum speed 50 - 55 kt, range 500 miles at 46 kt, complement 5 - 6; Guns: one 12.7 mm machine gun, one RPG-7 rocket launcher, one 106 mm recoilless rifle.

1.16.1.3 Three United States warships were directly involved: USS Vincennes, USS Elmer Montgomery and USS John H. Sides. The information given below was taken from the 1988/89 Edition of Jane's Fighting Ships.

USS Vincennes: Guided missile cruiser - AEGIS, maximum displacement 9600 tons, length 172.5 m, main machinery 4 General Electric LM 2500 gas turbines, 80000 shp, 2 shafts, maximum speed 30 kt, complement 358 (24 officers). Radar: Air search/fire control RCA SPY 1A phased arrays, 3 D, E/F band; air search Raytheon SPS 49 (V), C/D band, range 457 km.

Fire control: AEGIS Mk7 multi-target tracking; link 11 OE-82 satellite communications antenna; Lockheed SPQ 9, I/J band, range 37 km; four Raytheon/RCA SPG 62, I/J band.

ESM/ECM: SLQ 32V (3), combined radar warning and jammers.

SSR: Four SSR 1 receivers.

Anti-aircraft weapons: Surface air missiles, 68 GDC Pomona Standard ER-SM2, command/inertial guidance, semi-active homing to 137 km at 2.5 Mach, two twin-rail launchers.

Guns: Two FMC 127 mm/54 Mk 45, max elevation 65 degrees, anti-aircraft range 15 km, surface range 23 km; two General Electric/General Dynamics 20 mm/76 6-barrelled Mk 15 Vulcan Phalanx, range 1.5 km.

USS Elmer Montgomery: Knox class anti-submarine frigate, maximum displacement 4200 tons, length 133.5 m, maximum speed 27 kt, complement 288 (17 officers). Radar: Air search Lockheed SPS 40, E/F band, range 320 km.

Fire control: Western Electric SPG 53A, I/J band; OE-82 satellite communications antenna.
ESM/ECM: SLQ 32V (2), combined radar warning and jammers.
SSR: SSR 1 receiver.
Guns: one FMC 127 mm/54 Mk 42, max elevation 85 degrees, anti-aircraft range 14 km, surface range 24 km; one General Electric/General Dynamics 20 mm/76 6-barrelled Mk 15 Vulcan Phalanx, range 1.5 km.
USS John H. Sides: Oliver Hazard Perry class guided missile frigate, maximum displacement 3585 tons, length 135.6 m, maximum speed 29 kt, complement 206 (13 officers) including 19 aircrew.
Radar: Air search Raytheon SPS 49, C/D band, range 457 km.
Fire control: Lockheed STIR (modified SPG 60), I/J band, range 110 km; Sperry Mk 92 (Signaal WM 28), I/J band, range 7 km; OE-82 satellite communications antenna.
ESM/ECM: SLQ 32V (2), combined radar warning and jammers.
SSR: SSR 1 receiver.
Anti-aircraft weapons: Surface air missiles, 36 GDC Standard MR-SM1, semi-active homing to 46 km at 2 Mach, one Mk 13 launcher.
Guns: one OTO Melara 76 mm/62 Mk 75, max elevation 85 degrees, anti-aircraft range 12 km, surface range 16 km; one General Electric/General Dynamics 20 mm/76 6-barrelled Mk 15 Vulcan Phalanx, range 1.5 km.

2. ANALYSIS

2.1 Background information on the situation in the Gulf

2.1.1 As a result of difficulties experienced by international shipping in the Gulf, naval forces of several States entered the area to provide a protective presence and safeguard the freedom of navigation. The extent and intensity of hostile activities varied considerably from time to time. The incident on 17 May 1987 in which the USS Stark was severely damaged by two air-launched Exocet missiles was of particular relevance in the chain of events leading to the destruction of flight IR655.

2.1.2 The increasing tension in the area prompted warships to be concerned in particular with the identity and intentions of approaching aircraft. This led to a large number of challenges from warships to both civil and military aircraft. The challenges had been made to aircraft in low level transit, in high level cruise on airways, and on approach to or departure from airports in the area. Some challenges were reported to have been made to aircraft well inland and at a considerable distance from the warship concerned. Frequently, civil aircraft on ATS routes had been requested by warships on the emergency frequency 121.5 MHz to change course and to stay clear of the warships. In some cases, compliance with such instructions had caused air traffic conflicts of a potentially hazardous nature.

2.2 Notice promulgated by the United States

2.2.1 In early 1984 the United States had issued a notice that their naval forces in the Gulf, Strait of Hormuz, Gulf of Oman and Arabian Sea (north of 20 degrees north) were taking defensive precautions. Aircraft below 2000 ft which were not cleared for approach to or departure from an airport were requested to avoid flying closer than 5 NM to United States warships. The

notice further requested that aircraft approaching within 5 NM of United States warships must establish and maintain radio contact with them on 121.5 MHz or 243 MHz. It also stated that aircraft approaching within 5 NM below 2000 ft and whose intentions were unclear to United States warships may be held at risk by defensive measures.

2.2.2 Following the USS Stark incident a NOTAM Class I was issued in September 1987 to advise that United States warships in the area were taking additional defensive precautions. The notice stated that aircraft (fixed wing and helicopters) operating in the area should maintain a listening watch on 121.5 MHz or 243 MHz and that unidentified aircraft whose intentions were unclear or who were approaching United States warships would be contacted on these frequencies and requested to identify themselves and state their intentions. It also stated that in order to avoid inadvertent confrontation aircraft may be requested to remain well clear of United States warships. Failure to respond to requests for identification and indication of intentions, or to warnings, or operating in a threatening manner could place the aircraft at risk by United States defensive measures. Furthermore, illumination of a United States warship with a weapons fire control radar would be viewed with suspicion and could result in immediate defensive reaction. These measures would be implemented in a manner that would not unduly interfere with the freedom of navigation and overflight. The content of the NOTAM was also included in subsequent issues of the United States International Notices to Airmen publication, and was current on 3 July 1988.

2.2.3 The NOTAM was distributed to those States which had requested to be on the distribution list for NOTAMs issued by the United States FAA NOTAM Office under heading KFDC (Washington/National Flight Data Center, D.C.). In addition the NOTAM was distributed through official civil and military channels as well as through United States Embassies in the area.

2.2.4 Aeronautical information service authority. In accordance with the provisions of ICAO Annex 15, ICAO Contracting States provided an aeronautical information service and published aeronautical information concerning the territory of the State as well as areas outside its territory in which the State was responsible for air traffic services. International NOTAM Offices were designated by States for the international exchange of NOTAMs in accordance with the ICAO regional air navigation plans. The United States NOTAM concerning the Gulf, Strait of Hormuz, Gulf of Oman and Arabian Sea covered an area within the responsibility of International Notam Offices Abu Dhabi, Baghdad, Bahrain, Bombay, Karachi, Kuwait, Muscat and Tehran. Therefore, the promulgation of the NOTAM was not in conformity with the provisions of ICAO Annex 15.

2.2.5 Safety implications. The full implications of the rules of engagement of the United States warships were not sufficiently reflected in the notice promulgated by the United States. It was not specified what was considered to be "operating in a threatening manner", what distance was considered "well clear of United States warships", and what was meant with "could place the aircraft at risk by United States defensive measures". The safety risks imposed by the presence of naval forces in the Gulf area to civil aviation may have been underestimated, in particular as civil aircraft operated on promulgated tracks including standard approach and departure routes from airports in the area.

2.3 Problems to international civil aviation in the Gulf area

2.3.1 The presence and activities of naval forces in the Gulf area have caused numerous problems to international civil aviation. There were instances where civil ATC units overheard challenges to civil aircraft on the military air distress frequency 243 MHz (with which civil aircraft were not equipped) and were able to alert civil pilots to that effect. At least one flight had come into imminent danger of defensive measures before its identity could be established by the warship with the assistance of the civil ATC unit concerned. In some cases, flights chose to re-route in order to avoid challenges and possible danger from warships, thus accepting a significant mileage penalty with its economic consequences and inconvenience to passengers.

2.3.2 Civil aviation requirements such as airways, standard approach and departure procedures, and the fixed tracks used by helicopters to oil rigs were not a consideration in warship positioning. This resulted in warships challenging civil aircraft often in critical phases of flight, i.e. during approach to land and during initial climb. In the absence of a clear method of addressing challenged civil aircraft, such challenges were, on occasion, mistaken by pilots to whom the challenge was not addressed, causing additional confusion and danger.

2.3.3 Whilst some naval forces operated aircraft in communication with the appropriate ATC unit, others used aerodrome control zones and promulgated restricted areas without communication or co-ordination. This caused concern to the responsible ATC units in that it hampered the provision of positive air traffic control as a collision avoidance service.

2.4 Frequency and regularity of traffic on ATS route A59

2.4.1 Iran Air flight IR655 was a regular scheduled passenger service from Bandar Abbas to Dubai. During the month preceding 3 July 1988 the flight was operated twice a week, on Tuesdays and Sundays, with the exception of Sunday 19 June 1988. In addition there were 28 other Iran Air flights between Bandar Abbas and Dubai (or Sharjah). Furthermore, there were seven flights between Kabul and Dubai, and 23 flights between Kabul and Jeddah via ATS route A59.

2.4.2 Between 2 June 1988 and 3 July 1988 the traffic on route A59 amounted to a total number of 66 flights with an average of two flights per day and a maximum of six flights on 23 June 1988. Delays of flight IR655 were relatively small and these flights normally departed from the gate close to scheduled departure time.

2.5 "Red alert" procedure applied by Iranian air traffic services

2.5.1 ATS units in the Islamic Republic of Iran were notified through a "red alert" procedure of those military activities which posed a risk to the safety of civil aircraft. When a "red alert" was in effect, no ATC clearances were given to civil aircraft intending to operate through the affected airspace. In some instances Iranian aircraft already enroute had been recalled. On 3 July 1988 no "red alert" status was in effect and the ATC units at Tehran and Bandar Abbas were unaware of any activities at sea.

2.6 Radar coverage on airway A59

2.6.1 Radar Approach Control (RAPCON) at Bandar Abbas. The RAPCON unit at Bandar Abbas provided radar control service to military aircraft, and to civil aircraft on request. It was not normally used to monitor civil traffic and on 3 July 1988 the track of IR655 was not monitored. The equipment comprised an ASR-8 airport surveillance radar (primary radar) and a TPX-42 secondary surveillance radar (SSR), with a nominal coverage of some 60 and 200 NM respectively. However, the operational use was normally limited to some 30 NM. In addition precision approach radar (PAR) was available. It was stated that the military emergency frequency (243 MHz) receiver had been unserviceable and was still inoperative on 4 August 1988. Consequently, on 3 July 1988 communications on 243 MHz were not received.

2.6.2 Kish air defence radar. Flight IR655 was observed by the Iranian air defence radar located on Kish Island for approximately 48 seconds (four radar sweeps). The approximate position was given as 26 30 N, 056 00 E.

2.6.3 Radars in the United Arab Emirates. The controllers at Dubai and Abu Dhabi did not establish radar contact with flight IR655, nor did they normally monitor flights on airway A59 north of DARAX. The radar display at Dubai approach control was normally selected to a range of 60-80 NM to establish radar contact with inbound flights near DARAX.

2.7 IR655 VHF radio procedures

2.7.1 The Airbus A300, registration EP-IBU, was fitted with two King KTR 9100A VHF radios. Each transceiver was controlled by a dual selector control box on which two frequencies could be selected. A transfer switch allowed change from one selected frequency to the other.

2.7.2 Flight IR655 was in contact with Bandar Abbas control tower (118.1 MHz) whilst on the ground and with Bandar Abbas approach (124.2 MHz) after take-off. Whilst under the control of Bandar Abbas approach the flight passed a departure message to the Iran Air office at Bandar Abbas (131.8 MHz) and contacted Tehran ACC (133.4 MHz).

2.7.3 On 16 September 1986 Iran Air had issued a company advisory notice to flight crews operating in the Gulf area requiring the monitoring of frequency 121.5 MHz at all times. This notice was included in the briefing material for the IR655 flight crew on 3 July 1988.

2.7.4 Although there were no set procedures for the handling of the communications, information from Iran Air pilots and flight operations staff in Tehran indicated that at take-off the likely VHF selections were: Bandar Abbas tower (118.1 MHz) and Bandar Abbas approach (124.2 MHz) on VHF no. 1 and the company frequency (131.8 MHz) and 121.5 MHz on VHF no. 2. Tehran ACC (133.4 MHz) would have replaced Bandar Abbas tower on VHF no. 1 after take-off. The call made by IR655 to Tehran ACC whilst under the control of Bandar Abbas approach was not a required procedure but was common practice by flight crews. It was not apparent whether this call would have been made on VHF no. 1, thus accepting a brief interruption of guard of the approach frequency, or on VHF no. 2 which would not have allowed guard of 121.5 MHz for

a brief period. The flight remained under the control of Bandar Abbas approach from 0649:18 to 0654:11. The communication between IR655 and Tehran ACC took place between 0650:54 and 0651:30. The available information was not sufficient to determine which radio set was used for each transmission.

2.8 USS Vincennes

2.8.1 USS Vincennes joined the United States Joint Task Force Middle East in late May 1988. In this capacity USS Vincennes was directly involved in hostile activities for the first time on 3 July 1988.

2.8.2 Aircraft tracks in real time together with the civil ATS route structure and major airports in the Gulf area were displayed on two of the four AFGIS large screen displays in the Combat Information Centre. The area covered by the displays, and hence the degree of magnification of the projected pictures, could be varied by the operators as required by circumstances.

2.8.3 Information on civil flight schedules was available in the Combat Information Centre. However, it was pointed out that such information was, at best, of limited value in determining expected time of overflight. In the absence of flight plan and flight progress information, a realistic traffic picture could not be established and positive aircraft identification could not be obtained on that basis.

2.8.4 There was no co-ordination between United States warships and the civil ATS units responsible for the provision of air traffic services within the various flight information regions in the Gulf area. Such co-ordination would have enabled or at least facilitated identification of civil flight operations. The United States warships were not provided with equipment for VHF communications other than on the international air distress frequency 121.5 MHz. Thus, they could not monitor civil ATC frequencies for flight identification purposes.

2.8.5 In the process of determination of civil versus military and friendly versus hostile aircraft, a number of parameters were being taken into account. These were in order of importance:

- flight profile (speed range, rate of climb/descent, rate of turn, altitude);
- emissions from fire control radar, aircraft weather radar and radio altimeter;
- radio communications established; and
- IFF mode 3 (SSR mode A) responses.

2.8.6 With respect to warship radar surveillance of a given area of operation, it was normal practice to have more than one warship scanning the airspace. On 3 July 1988 USS Vincennes, USS Montgomery and USS Sides were in the north-western part of the Strait of Hormuz. While USS Montgomery was not able to cover the area, the other two warships monitored the radar track of IR655.

2.9 Electronic emissions and their detection

2.9.1 Aircraft weather radar. According to the United States report the warships had the capability to detect emissions from the type of weather radar carried by IR655. The report stated that no such emissions were detected by USS Vincennes, USS Montgomery or USS Sides. Information from Iran Air flight crews indicated that it would be reasonable to assume that in the weather conditions prevailing at the time of flight IR655, the flight crew would not have been operating the airborne weather radar.

2.9.2 Radio altimeters. IR655 was equipped with two radio altimeters. There was no indication of unserviceability on departure from Bandar Abbas. The radio altimeter installation on the Airbus A300 provided altitude information to the ground proximity warning system (GPWS) and both radio altimeters operated continuously during flight. The power supplies for the radio altimeters were controlled by the no. 1 and 2 radio master supply switches and there were no ON/OFF selectors for the radio altimeters on the flight deck. However, it was stated that radio altimeter emissions were not detected by the warships. According to the United States report there were no electronic emissions other than IFF mode 3.

2.9.3 Illumination with weapons fire control radar. The United States notice current on 3 July 1988, as well as previous issues, stressed that the illumination of a United States warship with a weapons fire control radar would be viewed with suspicion and could result in immediate defensive reaction. No United States warship was illuminated with a weapons fire control radar during the flight of IR655.

2.9.4 United States warships expected no reaction from a civil flight illuminated by fire control radar since civil aircraft did not carry detection equipment. IR655 was so illuminated by the USS Sides at approximately 0650 hours and by USS Vincennes prior to missile launch. There was no reaction from the contact (IR655) to either of these illuminations.

2.10 Analysis of the challenges made to IR655

2.10.1 A total of eleven challenges were broadcast by United States warships between 0649:39 and 0654:47 with respect to the radar contact (IR655). Seven challenges were made by USS Vincennes on the military air distress frequency 243 MHz. Three challenges were made by USS Vincennes and one by USS Sides on the international air distress frequency 121.5 MHz.

2.10.2 Military air distress frequency 243 MHz. A recording of communications on 243 MHz on 3 July 1988 was available from the Emirates ACC (Abu Dhabi). A transcript and recording was also available from USS Vincennes. There were seven challenges made to the radar contact (IR655) by USS Vincennes at 0649:39 - 0650:06, 0650:30 - 0650:49, 0651:11 - 0651:33, 0652:00 - 0652:21, 0652:44 - 0653:04, 0653:48 - 0654:10 and 0654:34 - 0654:47 hours. Except for the Italian warship Espero, no other stations reported having heard or recorded communications on 243 MHz at the time of flight IR655.

2.10.3 As civil aircraft did not carry radio equipment capable of being tuned to 243 MHz, these transmissions had no relevance as challenges to a civil aircraft.

2.10.4 Immediately prior to the challenges to IR655, between 0648:25 and 0649:28 hours, USS Vincennes was in radio communications with an Iranian P3 patrol aircraft 64 NM to the west. From 0656:15 hours onwards USS Vincennes challenged an Iranian C-130 aircraft.

2.10.5 International air distress frequency 121.5 MHz. A transcript and recording of messages broadcast on the international air distress frequency 121.5 MHz was available from the British warship HMS Beaver and from USS Vincennes.

2.10.6 Personnel at Dubai approach control had listened to their recording of 121.5 MHz for the period 0645 to 0715 hours on 3 July 1988, and reported that there were no messages recorded. The tape was not available. An operator of an oil company radio station located 40 NM south of Dubai reported having heard challenges on 121.5 MHz at about the time of flight IR655 and having recorded the last two or three messages. Requests to verify this report on site by interviewing the operator were denied. No other stations reported having heard or recorded transmissions on 121.5 MHz at that time.

2.10.7 The recording of frequency 121.5 MHz at Bandar Abbas ATC did not contain any communications from 0640 until 0656:43 hours when the latter part of a challenge was recorded. This recording corresponded to a challenge broadcast by USS Vincennes to another unidentified contact (military C-130) approximately two minutes after the destruction of flight IR655.

2.10.8 There were four challenges broadcast to IR655 on 121.5 MHz at 0650:02 - 0650:22, 0651:09 - 0651:43, 0652:33 - 0653:03 and 0653:25 - 0653:43 hours. The first three challenges were made by USS Vincennes, except that at the end of the second challenge when USS Vincennes transmitted "... request you alter course immediately over", USS Sides instantly added "to 270 immediately". The fourth challenge was made by USS Sides.

2.10.9 The challenges commenced approximately three minutes after take-off of IR655 from Bandar Abbas. By that time the flight crew would have completed their immediate after take-off actions. On reaching 1000 ft altitude the flight would have commenced flap retraction and transition from initial climb to enroute climb followed by the after take-off checks. During this time the call was made to the Iran Air office at Bandar Abbas with a departure message. From 0649:18 to 0649:43 hours the flight was in contact with Bandar Abbas approach. The flight crew would also have been preparing forward estimates for transmission to Tehran ACC. The contact with Tehran ACC took place from 0650:54 to 0651:30 hours. Further communication with Bandar Abbas approach with the MOBET position report and receiving instruction to change to Tehran ACC took place between 0654:00 and 0654:11 hours. It appeared that the first, third and fourth challenges made on 121.5 MHz were not co-incident with routine communications by the crew.

2.10.10 Information contained in the challenges on 121.5 MHz. It was relevant to examine whether the flight crew would have been able to readily identify themselves as the subject of the challenges on 121.5 MHz. The Iran Air flight crews were well versed with the use of English which was required by the Iranian Civil Aviation Authority. The majority of transmissions between IR655 and Bandar Abbas TWR/APP and Tehran ACC were conducted in English.

2.10.11 In accordance with the standard format of challenges United States warships should address unidentified aircraft as "unidentified aircraft on course ... , speed ... , altitude ... ". The standard format of warnings referred to the position of the warship as "bearing ... range ... from you". However, the information given in the transmissions from which an airline pilot would have to identify his particular flight varied from one transmission to the next (Table 1).

2.10.12 Course information. The course was given in degrees true and could be expected to be accurate. With a magnetic variation of one degree east in the area concerned, that course would correspond closely to the magnetic track of the aircraft. Although the course given may differ somewhat from the heading of the aircraft due to drift correction for cross-wind component, such difference was probably insignificant on flight IR655 in view of the estimated wind. The flight crew had heading and course information presented in degrees magnetic. Thus the course given could have been recognizable by the flight crew of IR655.

2.10.13 Speed information. The speed given in the transmissions was ground speed derived from radar information. Subject to the conditions of altitude, temperature and wind, ground speed could have been considerably different from indicated air speed (IAS) at which flight crews operated their aircraft.

2.10.14 The Airbus A300 could be expected to be climbing at 250 kt IAS up to FL100. In view of the high temperatures and the slight tailwind, as estimated from the available meteorological information, the ground speed in the phase up to FL100 at 250 kt IAS would have been over 300 kt. The speed given by USS Vincennes was 316, 350 and 360 kt. During the short period of climb above FL100 IAS would have been increased to 300 kt. The ground speed would have been of the order of 380 kt and this was recorded in USS Vincennes. Although the ground speed from radar data seemed accurate, it was apparent that at low altitude and at high temperature, the ground speed may not be readily recognizable to the pilot.

2.10.15 Altitude information. Altitude information based on SSR Mode C could be expected to be useful in establishing an association with the challenge. Such altitude information was given in the second and the third challenges on 121.5 MHz.

2.10.16 Bearing and range information. An airline pilot could not normally be expected to see and identify the source of the challenge, since this would depend on the altitude, visibility, and attitude of the aircraft. There may also be several other ships in the area not associated with the challenge. Therefore, bearing and range from the aircraft to the warship would only convey the immediacy of the problem, and would be of little or no assistance to civil flight crews in establishing whether their flight was the subject of the challenge. In addition, a range expressed in yards (fourth challenge) would be confusing.

2.10.17 Geographical co-ordinates. The first challenge issued to the unidentified aircraft (IR655) included aircraft position in geographical co-ordinates. Although it may be necessary to use geographical co-ordinates in an area where no other references are available, the transmission and

interpretation of such position information was time consuming and error prone, even in aircraft equipped with navigational equipment that could display such information. Thus, geographical co-ordinates were not a practical method of establishing identification.

2.10.18 SSR code. Only the fourth challenge, issued by USS Sides, included the SSR code displayed by IR655. This code being unique to a particular flight, recorded on the flight log and indicated on the SSR selector box, could be expected to be immediately recognizable to the flight crew.

2.10.19 There was no response to the four challenges made on frequency 121.5 MHz, either by radio or by a change of course. This indicated that the flight crew of IR655 either was not monitoring frequency 121.5 MHz in the early stages of flight, or did not identify their flight as being challenged.

2.11 Information available on USS Vincennes and action taken

2.11.1 The surface action involving USS Vincennes and small gunboats coincided with the perceived aerial threat. Intelligence information available to the United States Joint Task Force Middle East indicated the deployment of Iranian F-14 fighters to Bandar Abbas against the background of expected heightened hostile activities around 4 July. Furthermore, the possibility of Iranian air support in the surface engagements with United States warships could not be excluded in view of precedent albeit not with F-14 type fighter aeroplanes. Also, the actual take-off time from the joint civil/military aerodrome differed from the scheduled departure time of flight IR655 listed in the commercial schedule information available on the ship. The radar contact was briefly associated with an unrelated IFF mode 2 response. This information led to an initial identification of the aircraft (IR655) as a hostile F-14.

2.11.2 This was reinforced by the lack of response to the challenges and warnings on frequencies 121.5 MHz and 243 MHz. Electronic emissions of weather radar and radio altimeters were not detected by the United States warships and the radar contact was tracked on a course slightly diverging from the centerline of airway A59. Upon consultation, the Commander, Joint Task Force Middle East concurred with engagement of the target, in the event of lack of response to additional radio warnings.

2.11.3 All seven challenges issued by USS Vincennes on 243 MHz were addressed to Iranian aircraft, Iranian fighter or Iranian F-14. The third and fourth challenges contained the word fighter and the fifth challenge F-14. USS Vincennes also issued three challenges on the emergency frequency 121.5 MHz addressed to unidentified aircraft. There appeared to have been an emphasis on challenges on 243 MHz by USS Vincennes consistent with the perceived threat of possible F-14 activities.

2.11.4 Reports of changes in flight profile from climb to descent and acceleration were heard in the Combat Information Centre of USS Vincennes, as recalled by a number of personnel in the Combat Information Centre of USS Vincennes. The international air distress (IAD) operator and the military air distress (MAD) operator, who also was the automatic detection and tracking operator (49ADT), recalled perceiving from the AEGIS system the aircraft in a descending and accelerating profile towards the warships as announced in the Combat Information Centre. Nonetheless the 49ADT-MAD operator at 0652:00 and

0653:48 hours, and the IAD operator at 0652:33 hours issued warnings to the contact (IR655) containing correct AEGIS system information.

2.11.5 Considering itself and USS Montgomery under aggression, USS Vincennes took the ultimate decision to launch missiles against the perceived hostile target at 0654:22 hours.

2.11.6 The United States report stated that the data recorded from the AEGIS system of USS Vincennes was correct and consistent with the actual flight profile of IR655. However, a number of operators misread the displays and wrongly interpreted the information. The report described in detail recollections by operators on USS Vincennes and the circumstances in which the unidentified aircraft (IR655) was associated with an IFF mode 2 code, rapidly decreasing altitude and increasing speed, and thus evaluated as a hostile military aircraft. The United States report and the endorsements by the Chairman, Joint Chiefs of Staff and the Commander in Chief, United States Central Command are appended.

2.11.7 Positions of USS Vincennes and IR655. The position of USS Vincennes at the time of missile launch based on the AEGIS-system data was given as 26 30 47 N, 056 00 57 E and that of flight IR655 as 26 40 06 N, 056 02 41 E. At missile intercept the position of USS Vincennes was given as 26 30 51 N, 056 01 04 E and that of flight IR655 as 26 38 22 N, 056 01 24 E. Thus the position of IR655 at missile intercept would be approximately 10 NM south-southwest of MOBET and approximately 3.7 NM west of the centreline of airway A59, and the position of USS Vincennes approximately 17 NM south of MOBET. USS Montgomery had observed the flash of missile impact and the descent of the aircraft towards the sea in a flat spin with one wing and the tail section missing. The wreckage impact point on the surface of the sea was given as 26 37 45 N, 056 01 E, i.e. some 11 NM south-southwest of MOBET.

2.11.8 The climb profile of IR655 (Figure 1) based on AEGIS-system data from USS Vincennes shows IR655 at 12000 ft at approximately 0653:50 which corresponds to the position report at 0654:00 from IR655 to Bandar Abbas APP "MOBET out of FL120". However, based on the positions given by USS Vincennes, IR655 passed MOBET at approximately 0653:10, thus indicating that the position report by IR655 was given some 5 NM after MOBET.

2.11.9 Most of the recovered bodies and floating parts of the aircraft were found in an area around 26 43 N, 056 02 E. Taking into account an estimated 3 kt tidal flow towards the west as given by USS Vincennes, this would indicate a position of impact with the sea in an area some 5 NM south-southwest of MOBET.

2.12 Information available on USS Sides and action taken

2.12.1 USS Sides did not issue challenges on 243 MHz. At the end of the second challenge when USS Vincennes transmitted on 121.5 MHz "request you alter course immediately", USS Sides instantly added "to 270 immediately". The fourth and last challenge on 121.5 MHz was issued by USS Sides and was addressed to "unidentified aircraft squawking 6760 mode 3". This was the SSR code displayed by IR655.

2.12.2 Several operators on USS Sides recalled having seen only IFF mode 3 codes between 0647 and 0654 hours, and no IFF mode 2 codes. Two operators recalled that the unidentified aircraft was evaluated as a commercial flight at 0651 hours and so reported to the tactical action officer, who did not recall having heard this report. According to the United States report there was at 0653 hours growing excitement and shouting in the Combat Information Centre of USS Sides about a commercial flight. Also the Commanding Officer of USS Sides recalled having evaluated at 0653 hours the unidentified aircraft as a non-threat to USS Sides based on the closest point of approach, his knowledge of F-14 anti-surface warfare capability, lack of electronic signature and lack of precedent, noting altitude 11000 ft, and having shifted his attention to the Iranian P3 some 60 - 70 NM to the west.

TABLE 1: CHALLENGES TRANSMITTED ON 121.5 MHz TO IR655 BY US WARSHIPS

TRANSMISSION	CALL SIGN	INFORMATION					REQUEST	OTHER INFORMATION
		Course	Speed	Altitude	Bearing	Range		
US PROCEDURE Challenge or Warning	Unidentified Aircraft						Establish communi- cations; Alter course to --	-
Actual Transmissions 1 Vincennes (0650:02)	Unidentified Aircraft						Remain clear	Geographical position co-ordinates
2 Vincennes (0651:09)	Unidentified Aircraft						Remain clear; Alter course to 270	
3 Vincennes (0652:33)	Unidentified Aircraft						Remain clear	
4 Sides (0653:25)	Unidentified Aircraft						Alter course to 270	SSR code 6760

FIGURE 1: Flight profile of IR655
 FIGURE 1: Profil du Vol IR655
 FIGURA 1: Perfil de vuelo del IR655

Рис. 1. Профиль полета самолета авиакомпании "Иран Эр", выполнявшего рейс 655

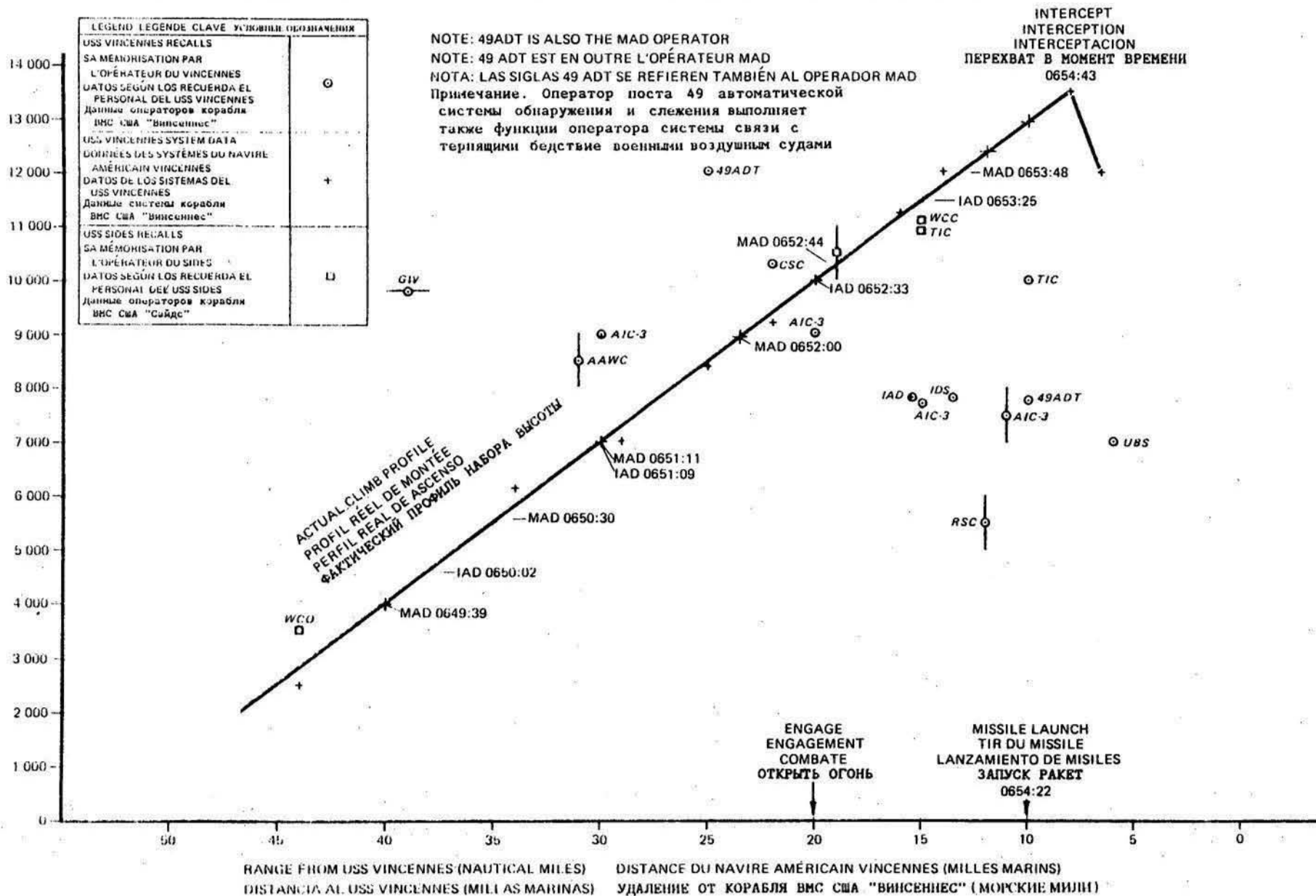
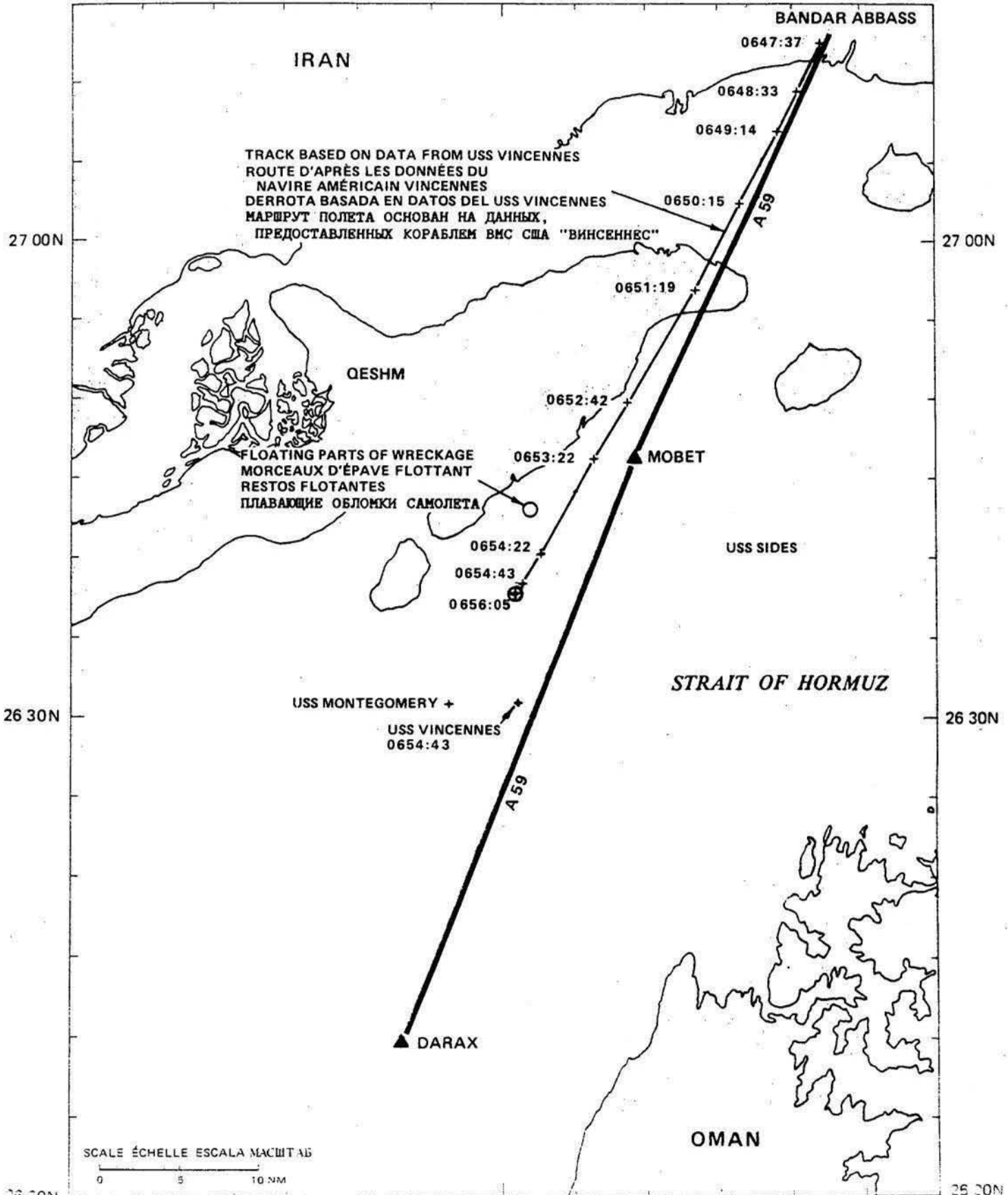


FIGURE 2: Track of IR655
 FIGURE 2: Route d'IR655
 FIGURA 2: Derrota del IR655

Рис. 2. Маршрут полета самолета авиакомпании "Иран Эр", выполнявшего рейс 655
 56 00 E



3. CONCLUSIONS

3.1 Findings

- 3.1.1 The flight crew of flight IR655 was properly certificated and qualified for the scheduled international passenger flight in accordance with existing regulations. There was no indication that the flight crew may not have been physically or psychologically fit.
- 3.1.2 The aircraft was properly certificated, equipped and maintained in accordance with existing regulations and approved procedures. The aircraft was serviceable when dispatched from Bandar Abbas.
- 3.1.3 There was no indication of failure during flight in the equipment of the aircraft including the communications and navigation equipment.
- 3.1.4 The wreckage including the digital flight data recorder and the cockpit voice recorder had not been recovered by 16 October 1988.
- 3.1.5 On 3 July 1988 the Bandar Abbas VORTAC was operating normally, although its flight check had expired on 21 May 1988. A flight check carried out on 30 July 1988 found the facility operational without discrepancy.
- 3.1.6 On 3 July 1988 no "red alert" status was in effect and the ATC units at Tehran and Bandar Abbas were unaware of any activities at sea.
- 3.1.7 Flight IR655 departed Bandar Abbas airport terminal 20 minutes after the scheduled time.
- 3.1.8 The flight crew had correctly selected SSR mode A code 6760. SSR mode C (automatic pressure altitude transmission) was functioning.
- 3.1.9 After take-off the aircraft climbed straight ahead enroute and the climb profile was normal. It followed airway A59 and remained well within its lateral limits. The use of FL140 or FL160 was normal for flights on airways A59 and A59W from Bandar Abbas to Dubai.
- 3.1.10 The aircraft weather radar was probably not operated during the flight nor would normal procedures have required its operation in the prevailing weather conditions. The radio altimeters were probably functioning throughout the flight.
- 3.1.11 No electronic emissions from the aircraft, other than SSR responses, were detected by United States warships.
- 3.1.12 The flight crew carried out normal VHF communications with ATC units concerned.
- 3.1.13 Apart from the capability to communicate on the emergency frequency 121.5 MHz, United States warships were not equipped to monitor civil ATC frequencies for flight identification purposes.
- 3.1.14 The flight crew was aware of the Iran Air company instruction to monitor frequency 121.5 MHz at all times while operating in the Gulf area.

- 3.1.15 Four challenges addressed to an unidentified aircraft (IR655) were transmitted by United States warships on frequency 121.5 MHz (three from USS Vincennes and one from USS Sides).
- 3.1.16 There was no response to the four challenges made on 121.5 MHz, either by radio or by a change of course. This indicated that the flight crew of IR655 either was not monitoring 121.5 MHz in the early stages of flight, or did not identify their flight as being challenged.
- 3.1.17 The aircraft was not equipped to receive communications on the military air distress frequency 243 MHz.
- 3.1.18 The civil ATS route structure and major airports in the Gulf area were displayed on AEGIS large screen displays in the Combat Information Centre. The information did not include all types of promulgated airspace, in particular airway widths, low-level helicopter routes, standard departure and arrival routes and airspace restrictions. The information displayed together with aircraft tracks in real time appeared adequate for the projection of a two-dimensional air traffic situation. However, the absence of altitude information on the large screen displays did not allow ready assessment of flight profiles in three dimensions.
- 3.1.19 Information on civil flight schedules was available in the Combat Information Centre of USS Vincennes. However, in the form presented, it was of extremely limited value for the determination of estimated time of overflight of individual aircraft. Flight plan information and flight progress data, including information on assigned SSR mode A codes, were not available to assist in flight identification.
- 3.1.20 There was no co-ordination between United States warships and the civil ATS units responsible for the provision of air traffic services within the various flight information regions in the Gulf area.
- 3.1.21 Iran Air flight crews were well versed with the use of English and the majority of communications between IR655 and Bandar Abbas TWR/APP and Tehran ACC were conducted in that language.
- 3.1.22 The contents of the challenges and warnings issued to IR655 on 121.5 MHz varied from one transmission to the next. It is uncertain whether the flight crew would have been able to rapidly and reliably identify their flight as the subject of these challenges and warnings. Although course information given could have been recognizable to the flight crew of IR655, speed information given on the basis of ground speed may not have been recognizable by the pilot. Bearing and range information to the warship was of little relevance to the pilot. Position information in geographical co-ordinates was not a practical method to establish identification. The SSR mode A code displayed by IR655 could have been immediately recognizable to the flight crew, but was given only in the final challenge.
- 3.1.23 The initial assessment by USS Vincennes that the radar contact (IR655) may have been hostile, was based on:

- a) the fact that the flight had taken off from a joint civil/military aerodrome;

- b) the availability of intelligence information on Iranian F-14 deployment to Bandar Abbas and the expectation of hostile activity;
- c) the possibility of Iranian use of air support in the surface engagements with United States warships;
- d) the association of the radar contact with an unrelated IFF mode 2 response; and
- e) the appearance of an unidentified radar contact that could not be related to a scheduled time of departure of a civil flight.

3.1.24 The continued assessment as a hostile military aircraft by USS Vincennes and the failure to identify it as a civil flight were based on the following:

- a) the radar contact had already been identified and labelled as an F-14;
- b) the lack of response from the contact to the challenges and warnings on frequencies 121.5 MHz and 243 MHz;
- c) no detection of civil weather radar and radio altimeter emissions from the contact;
- d) reports by some personnel on USS Vincennes of changes in flight profile (descent and acceleration) which gave the appearance of manoeuvring into an attack profile; and
- e) the radar contact was tracked straight towards USS Montgomery and USS Vincennes on a course slightly diverging from the centreline of airway A59.

3.1.25 Reports of changes in flight profile from climb to descent and acceleration were heard in the Combat Information Centre of USS Vincennes, as recalled by a number of crew members including the operators who at that time issued the challenges on 121.5 MHz and 243 MHz containing correct AFGIS system information.

3.1.26 USS Vincennes AEGIS system contained and displayed correctly the IFF mode and code, and the altitude and speed information of the contact (IR655). The AEGIS system recorded a flight profile consistent with a normal climb profile of an Airbus A300.

3.2 Causes

3.2.1 The aircraft was perceived as a military aircraft with hostile intentions and was destroyed by two surface-to-air missiles.

3.2.2 The reasons for misidentification of the aircraft are detailed in the findings (paragraphs 3.1.23 and 3.1.24).

4. SAFETY RECOMMENDATIONS

4.1 In areas where military activities potentially hazardous to civil flight operations aircraft take place, optimum functioning of civil/military co-ordination should be pursued. When such military activities involve States not responsible for the provision of air traffic services in the area concerned, civil/military co-ordination will need to include such States. To this end:

- a) Military forces should, initially through their appropriate State authorities, liaise with States and ATS units in the area concerned.
- b) Military forces should be fully informed on the extent of all promulgated routes, types of airspace, and relevant regulations and restrictions.
- c) Advance information on scheduled civil flights should be made available to military units including the allocated SSR mode A codes when available.
- d) Direct communications between military units and the appropriate ATS units, not using regular ATC or the emergency frequencies, should be established for the exchange of real time flight progress information, delays and information on non-scheduled flights.
- e) Military units should be equipped to monitor appropriate ATC frequencies to enable them to identify radar contacts without communication.
- f) If challenges by military units on the emergency frequency 121.5 MHz become inevitable, these should follow an agreed message format with content operationally meaningful to civil pilots.
- g) In areas where such military activities occur, information necessary for the safety, regularity and efficiency of air navigation should be promulgated in a suitable form. The information should contain the type of challenges that might be transmitted, and should include instructions to pilots of civil aircraft to monitor the emergency frequency 121.5 MHz.
- h) To assist identification by electronic emissions, pilots of civil aircraft should ensure continuous operation of airborne weather radars and radio altimeters.