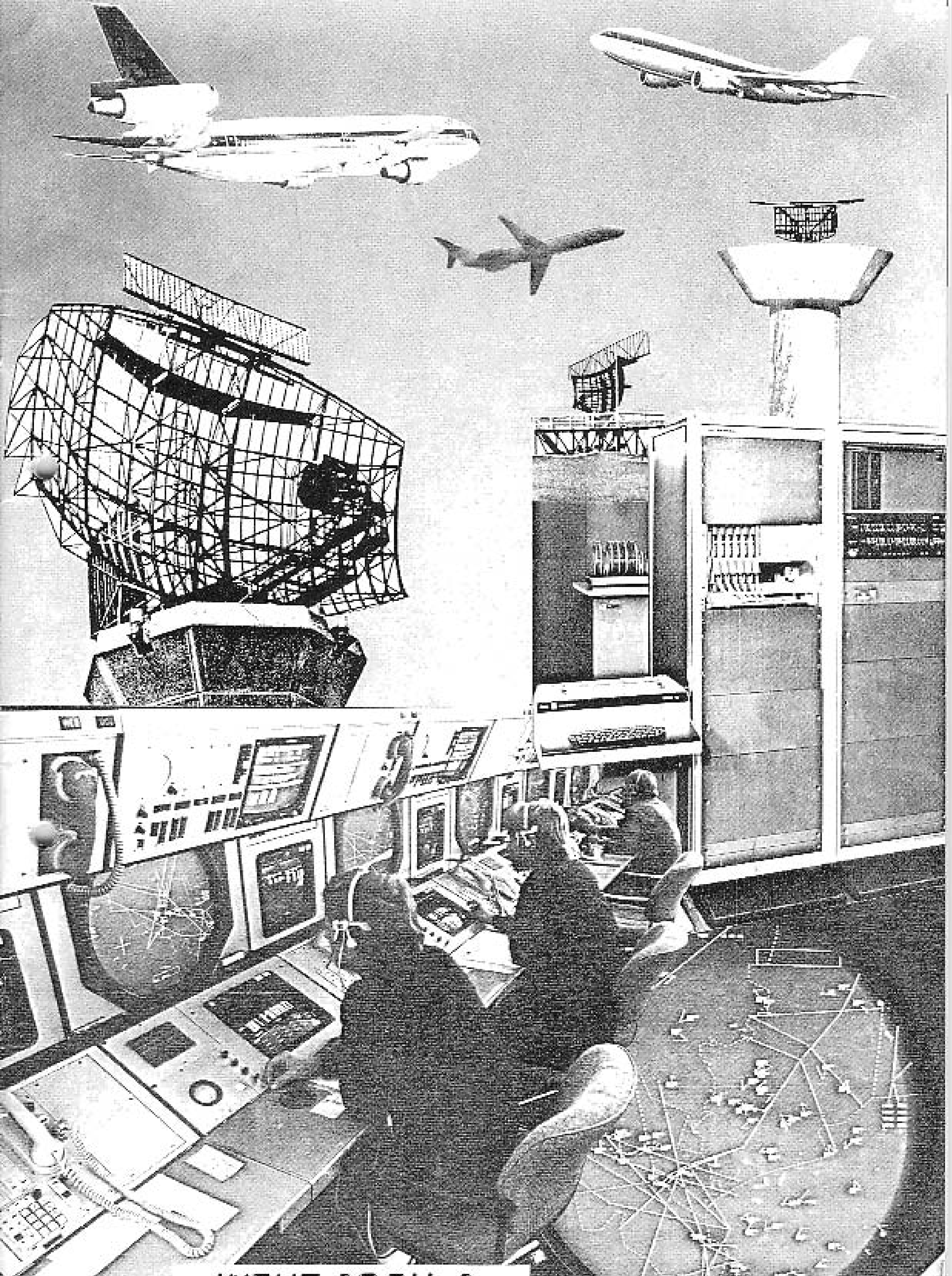

INPUT 1984..1

INPUT

the magazine of the
EUROCONTROL GUILD of AIR TRAFFIC SERVICES

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OutputOutputOutput

MULTI-RADAR COVERAGE. Each aircraft in the Maastricht area is tracked on the basis of information received from two or in many occasions even three radar sites. The accuracy attained in radar positioning is considerable. Martin kindly designed a front cover, depicting the Maastricht environment, which will be used for the 1984 issues. It will certainly enhance our image and INPUT will unmistakebly be recognised as the EGATS magazine.

This year's first issue is in particular devoted to occurrences with fatal consequences and its causes. Eurocontrol Headquarters responded rapidly by approving the publication of some articles, which provide interesting information about new developments within Eurocontrol.

Before you start the main dish I would like to draw your attention to a new activity organised by EGATS. On 12th April 1984, Dr. Brouwers will give a presentation about "Stress in ATC". Further information will be soon available.

Rob.

Safety of Air Navigation in Europe

The following is an extract of a Report from the Transport Committee of the European Parliament by Mr. C.Ripa di Meana. Henk van Hoogdalem has selected the most interesting items. It has to be taken into account that the statistical information is based on IATA reports only and therefore the figures may turn out less propitious in reality.

From the Draft-Resolution

Considering that,..

1. The high degree of safety of air-navigation in Europe needs to be maintained and even improved with respect to the expected increase of air traffic.
2. The economical problems of the member-States (EEC) could lead to cuts in expenditure with regard to equipment, which in turn may be detrimental to safety in air navigation.
3. The air-routes of civil and military air traffic cross each other frequently.
4. Determines that the ATC systems differ remarkably between the member-States and in addition between member-States and applicant member-States.
5. Holds the view that all member-States must be equipped with comparable technological systems and should preferably use standardized equipment and apparatus designed in Europe.
6. Calls attention to the disturbances of air/ground communications, mainly caused by radio-, TV- and CB-transmitters.
7. Requests to improve the quality of weather information, such as "windshear", "clear air turbulance" and "bird ingestion".
8. Establishes that ATC centres communicate according elementary procedures which may fail, while more advanced and reliable automatic coupling-systems could be used (e.g. ACT exchange between Maastricht UAC and London ATCC).
9. Wishes that schooling (basic training and refresher-courses) of air traffic controllers is improved, in view of fast and continuously changing techniques.

The available information on "Safety in Air-Navigation" in Europe is completed by means of:

- a questionnaire sent to all European airlines and organisations, pilots' and controllers'

associations and international organisations.
- requests for information from military and civil authorities about "air-misses" (some States were rather reserved),
- meetings with representatives of pilots' and controllers' associations, airlines and authorities.

Circumstances involving aircraft incidents/accidents

In air transport an average of some 800 - 1000 people per year are killed. The number of accidents per million flights is
- worldwide : 3
- in Europe : 1.

Of all accidents/incidents 75% occur in the vicinity of airports (start 20%, climb-out 5%, approach 23% and landing 22%), and 14% take place during cruise.

The following numbers of air-misses were recorded in 1982:

Belgium (B)	5
West Germany (W.G.)	40
Greece (G)	19
France (F)	31
Italy (I)	13
The Netherlands (N)	6
United Kingdom (U.K.)	21
Spain (S)	35

Over the last five years the following tendency can be observed:

	1977	1978	1979	1980	1981
B	14	9	4	5	2
W.G.	82	70	60	56	51
G	11	10	10	5	17
F	63	68	54	31	25
I	15	14	10	12	18
N	8	8	7	8	13
U.K.	35	39	36	29	32
S	54	66	46	34	25

A rather spectacular decrease of air-misses over West Germany and Belgium, whilst the figures of Italy remain fairly constant and those of Greece increase. The number of air-misses with a high risk of collision is particularly high in France and Spain.

A differentiation with regard to the type of aircraft involved:

	Civil/ Civil	Civil/ Military
France	18	4
W. Germany	2	15
Greece	13	6
United Kingdom	8	9

Based on faults of:

	civil controller	civil pilot	mil. pilot
F	11	6	-
W.G.	6	1	10
G	9	4	2
U.K.	7	2	1

Based on conversations and statistical recordings one may assume that the number of air-misses has to be multiplied by 2 or 3 to arrive at more realistic figures. The information of national administrations was not disclosed by the General Directorate of Eurocontrol.

Radar coverage in Europe

Radar control over mid Europe is satisfactory and the report mentions the ATC centre at Maastricht as the most advanced centre in the world. Italy will soon introduce a multi-radar-tracking system; the ATC system of Greece needs to be modernized. In Spain and Portugal exists insufficient radar coverage.

A major problem is that the different computer systems are not connected to each other (all information has to be passed by telephone or telex). An automatic link exists between Maastricht UAC and London ATCC (and will soon be introduced between Maastricht and Rhein, and Maastricht and CORTA. - H.v.Hoogdalem).

Radio jamming

The quality of R/T communications determines the degree of safety and efficiency. The increase of magnetic interferences influences air/ground radio communications negatively and are probably brought about by radio-, TV- and CB-transmissions. Measures against disturbances of frequencies can only be taken by law adjustments.

ATC procedures in Europe

The European situation verges on the ridiculous: 17 regional ATC centres using different technical systems. Quite a contrast with the United States, four times as large as Europe and only 20 ATC centres, which are to be reduced to 12.

Some aspects to be taken into account when a reduction of the number of centres is pursued:

1. The financial aspect: a study in 1978 indicates that the total costs per 100 hours of flight average to $44 per national centre and $32 per centralized (European) centre.
2. Harmonisation of procedures and equipment increases the safety and efficiency; in addition it simplifies the work of pilot and controller.

Military and civil airspace

Military and civil ATC operate separately in all member-States of the Common Market. The airway system is not optimal at all; if it would be a reduction of 15% in flying time and costs of air-transport could be achieved. A positive remark is made with respect to Eurocontrol, where military and civil controllers work side by side with the same equipment.

It is often reflected by civil pilots that the careless attitude of some military pilots is the cause of a number of incidents/air-misses. Obviously these military pilots have the opinion that greater speeds and perfect radar equipment permit them to disregard some rules of the air.

Human factors

According to an IATA investigation in 1975, 70% of all accidents are caused by human errors.

Too advanced techniques may have negative or even ill consequences. The "better" equipped aircraft are, the more attention and concentration is required from the crews; primarily on longer flights these will decrease. The psychological circumstances in which crews find themselves are extremely important. It is therefore proposed to carry out extensive research programmes before new techniques are implemented.

Note (H.v.Hoogdalem): In general it can be said that any system with a high degree of technology may influence human behaviour (pilot, controller or anyone else) negatively. The required level of concentration cannot always be reached as one has to learn how to use the new equipment with all its benefits and how to pay attention to different tasks.

civilmilitarysidebysidesectorconfiguration

C.M.S.B.S.S.C.

....THE COORDINATION HAS AGAIN IMPROVED, OF COURSE THERE ARE MINOR DIFFERENCES.....

The Central Data Bank (CDB), an Impression

by Bob van der Flier

Since we were well briefed on where to find the CDB, we arrived there quite easily. We were welcomed by Mr. Valdenaire, on behalf of Mr. Brian Martin, Head of Operations Department, who was absent on a mission.

In a well-furnished, pleasant office we received an introduction and a short history of the CDB and the various meetings and decisions which have led to the present stage. A great deal of work has been done already, but a lot is still pending. After this introduction we descended from the 5th floor to the ground floor to visit the computer and operations room (IBM 4341 with the usual additional equipment). Then we climbed up again to the 5th floor, where the different possibilities and practical abilities of the system were demonstrated.

Very briefly explained, one can divide the CDB system into two parts:

1. What one can call an AIS part, and
2. What one can call a flight-plan part.

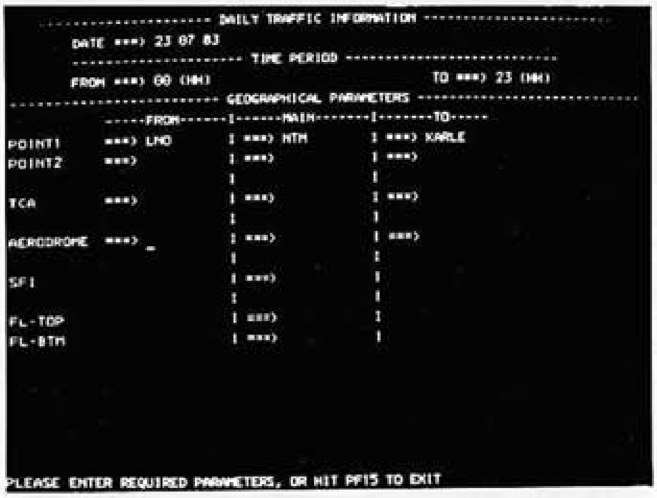
Part 1. The AIS side. At the initial stage the CDB covers the following area: the FIRs of the FRG, Austria, Yugoslavia, Greece, Switzerland, Italy, Spain and the Canaries, Portugal and the Azores, France, Belgium, UK, the Netherlands and Denmark. Within this area, over 1500 aerodromes, over 1500 navigation aids, 600 way-points (intersections), 1000 ATS routes, 40.000 standard routes and 850 sectors.

Of all these aerodromes, navigation aids, way-points and sectors basic information is available, such as: geographical coordinates, main runway (statistically the one mostly used), distance from the main approach fix to the main-runway, possible sectors (low, middle, high) with the vertical limits, areas, hours of activation (e.g. airways being used only once a month), serviceability. Furthermore, availability of flight levels per route or route-segment (level allocations). Standard routes refer to all standard connections between any pair of aerodromes. In addition special tables are available with aerodromes outside the CDB area to enable the connections to or from entry or exit points of the CDB area (e.g. USA aerodromes for transatlantic flights to be connected to the different transatlantic exit points (eastbound flights) which in turn allows for a connection to the specific airways used thereafter to the indicated aerodrome of destination).

Many problems were encountered with the different abbreviations of the navigation aids, being used several times over the whole of Europe, or (weekend and white) airways with the same designators in different countries. Moreover airways used in one way in one country, two way in another country or not used at all in a particular sector due to the vertical limits.

All this information is gathered from 35 AIPs and kept up to date by information received through Class II Notams, AICs and AIRACs.

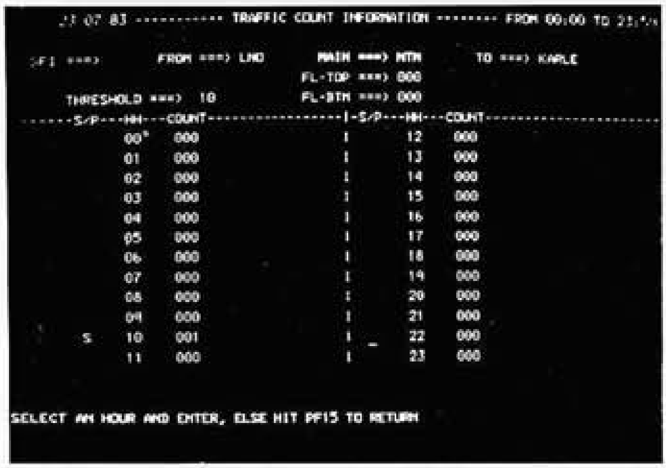
Part II. Flight plan information. Either derived from the ABC-manual, RPL, FPL or mailed listings and active for example during one, two or three days a week or on a daily basis. When made known, they are in the computer files. Together with that as basic information, the computer carries tables of aircraft performances (standard), all different types of aircraft used in world aviation (e.g. B707 is known as a 707-200 or 707-300, 701, 702, 703, military, passenger, freight or combined version; each individual type with different performances and different maximum flight level in short haul or long haul version, and so on).



```
.................... DAILY TRAFFIC INFORMATION ......................
    DATE ***) 23 07 83
    .................... TIME PERIOD ........................
    FROM ***) 00 (HH)                               TO ***) 23 (HH)
........................ GEOGRAPHICAL PARAMETERS ........................
            -----FROM------I------MAIN-------I-------TO-----
POINT1      ***) LNO       I ***) NTM        I ***) KARLE
POINT2      ***)           I ***)            I ***)
                           I                 I
TCA         ***)           I ***)            I ***)
                           I                 I
AERODROME   ***) _         I ***)            I ***)
                           I                 I
SFI                        I ***)            I
                           I                 I
FL-TOP                     I ***)            I
FL-BTM                     I ***)            I

PLEASE ENTER REQUIRED PARAMETERS, OR HIT PF15 TO EXIT
```

An example of a request for the number of flights overflying NTM from LNO to KARLE for each hour of the day.



```
   23 07 83 ........... TRAFFIC COUNT INFORMATION ........ FROM 00:00 TO 23:[illegible]

SFI ***)        FROM ***) LNO       MAIN ***) NTM        TO ***) KARLE
                                  FL-TOP ***) 000
   THRESHOLD ***)  10             FL-BTM ***) 000
-----S/P---HH---COUNT-----------------I-S/P---HH---COUNT--------------------
           00*   000                  I        12   000
           01    000                  I        13   000
           02    000                  I        14   000
           03    000                  I        15   000
           04    000                  I        16   000
           05    000                  I        17   000
           06    000                  I        18   000
           07    000                  I        19   000
           08    000                  I        20   000
           09    000                  I        21   000
      S    10    001                  I  _     22   000
           11    000                  I        23   000

SELECT AN HOUR AND ENTER, ELSE HIT PF15 TO RETURN
```

The hourly traffic counts as reply to the request above.

A combination of the data available through the above mentioned parts 1 and 2 makes it possible to count the number of flights per area, per sector, per airway (or even part of an airway), per FL and per navigation aid or way-point. In other words, with the data made available it is possible to show information such as load figures per area, sector, aerodrome, navigation aid or route (segment) for any hour of the day. A further sub-division is possible by showing the amount of aircraft foreseen on a route from A through point X at FL Y to B between hour n and hour n+i (i=anything up to 24 hours; e.g. the amount of flights from EGLL to EDDM via NTM at FL 330 between 12.00 and 13.00 for a certain day).

```
 - 23 07 83 ........... TRAFFIC LISTING .................... FROM 10:00 TO 1[illegible]

SFI ***)     FROM ***) LNO        MAIN ***) NTM              TO ***) KARLE
                                FL-TOP ***) 000
 THRESHOLD ***) 010             FL-BTM ***) 000              COUNT ***)   1
-ENTRY---C/S------A/C--DEP--DES---FL--I--ENTRY---C/S------A/C--DEP--DES---FL---
_1018  BB100     B707 EBBR LIRF 000  I
                                     I
                                     I
                                     I
                                     I
                                     I
                                     I
                                     I
                                     I
                                     I
                                     I
                                     I
```

By selecting hour 10 on the previous display (S) all flight data of the traffic in that period will be made available.

Specially mentioned are the difficulties in respect of the different "languages" used in world aviation. For instance different abbreviations for aerodromes, types of aircraft and company names in ICAO and IATA language. Having regard to the possible different users in the operational stage later on, it is observed that some are only familiar with one language and not with the other. Therefore the different possibilities are indicated in the computer files.

Having indicated only a little of the information that can be made available and without going too much into detail, the question remains who can do what, where and when with these possibilities of the CDB?

Mainly there are two types of users:

a. Flow Management Units or Positions:

1. These units will have an up to date file for the whole of Europe in respect of Aeronautical Information (use of airways, standard routes, route orientation, FL allocation scheme, etc.) to facilitate re-routing depending on the availability of alternative routes.

2. Air Traffic load figures for whatever area, aerodrome or point in Europe for strategical use, which may lead to tactical measures (restrictions) as appropriate.

3. Replacement of departure lists, Traffic Flow Information Service (TFIS), traffic prediction schemes, etc., to allow preplanning and early warning on possible congestion or traffic separation problems.

b. ATC units:

1. As mentioned under a.2 and 3 above, to evaluate expected traffic loads, which may lead to tactical measures.

2. To better utilize available personnel (e.g. swap people from a swing to a morning duty, to better handle an early morning peak), or to collapse or de-collapse sectors well in time, as appropriate.

3. Eventually to evaluate the necessity of re-alignment of sectors, implementation of dualized airways, etc.

To come to a final conclusion, I would like to state that this is a very sophisticated tool for the aviation world, be it flow management units, ATC units, or any other organisation that might benefit from it in the future. This is in fact the standard tool we've been waiting for for a long time!

Accident Report DC9 Inex Adria Ajaccio 1st December, 1981

The original report of the French and Yugoslav investigation team is a document of 31 pages, published in the "Journal Officiel de la République Française", 7th December 1983. Although I've tried to be as accurate as possible the following is only a Summary and a Translation of the original report and should be treated as such.

Aircraft: DC9-82, Inex Adria YU-ANA, brand new, 683 hours since the first flight on 11th August, 1981. Seating capacity 167. R/T call sign: JP 1308.

Pilots: Captain - 55 years old; total flying hours: 12.123, of which 5.675 hours on DC-9 and 188 hours on DC9-82. Co-pilot - 40 years old; total flying hours: 4.213, of which 756 hours on DC-9 and 288 hours on DC9-82. Both were fully licenced and medically fit.

Controllers: 2 controllers were on duty that morning. APP Controller: 24 years old, qualified TWR since 20 DEC 80 and qualified APP since 4 NOV 81. 2nd Controller: acting as assistant, 29 years old, transferred to Ajaccio in AUG 80, qualified APP since 26 NOV 80. Both were qualified and medically fit.

Passengers: 130 charter passengers plus 43 employees of Inex Adria or Kompass Travel Agency (organisor of the flight) and members of their families. There were 2 pilots, 4 stewardesses and 1 ground engineer on the crew manifest. Total persons on board: 180, all killed.

Navigational aids: AJO VOR/DME, FGI VOR, FA NDB, the radio-beacons IS, CT, RO and the ILS were functioning normally.

Weather: Strong westerly winds (at FL100: 280°/40-50 kts, on the ground: 280°/16-20 kts), clouds in the mountains and clear over the sea. Not unusual for that time of the year in Ajaccio.

Controller Workload: The controller had only one aircraft under control (JP 1308) at all times.

TRANSCRIPT R/T RECORDING AND COCKPIT VOICE RECORDING (CVR)

Legend:
normal typing : R/T recording
CAPITALS : CVR (in Serbian)
CAPITALS : Ground Proximity Warning System (GPWS)
* : unreadable part
.... : pause

07.47.10. - JP: Bonjour Ajaccio Adria JP 1308 we are level 110 approaching Ajaccio VOR and further descent.

07.47.22. - APP: JP 1308, Ajaccio Approach, good morning, number 1 in approach, you maintain FL110 until you reach AJO VOR, it will be for a procedure from the VOR, QNH 1009, QFE 1008, wind is 280 degrees for 20 knots. Runway 21 in use, you report over AJO VOR and then descending over AJO VOR.

07.47.57. - JP: Roger, sir, that means we are maintaining 110 until AJO VOR. In holding pattern we'll have to descend. At the moment maintaining 110. Runway 21 in use, wind is from 180-20 knots, QNH 1009.

07.48.16. - APP: Ah ... I confirm the surface wind is 280-16 knots now and the wind is from 26 for 280-20 knots.

07.48.30. - JP: Thank you, copied weather and wind, call you over Ajaccio in holding.

07.49.31. - JP: Just Ajaccio VOR, level is 110 in holding pattern.

07.49.36. - APP: Roger, 1308 report leaving AJO on radial 247 for final approach.

07.49.44. - JP: OK sir, we are just over Ajaccio VOR and we are requesting further descent.

07.49.52. - APP: 1308, you are cleared to descend to 3000 and XXXXX (unreadable, could be 300 feet), QNH 1009 on the radial 247 AJO and you report leaving AJO.

07.50.05. - JP: Roger, will do. We are leaving 11 for 3000, radial 247, out of 110 QNH repeat again, 1009.

CVR2: RADIAL 247.

CVR1: * YES AND *

07.50.14. - APP: I confirm QNH 1009.

07.50.19. - JP: ... 09, and we are holding over Ajaccio, call you inbound on radial 247.

07.50.28. - APP: Roger.

CVR2: * WE WILL LIKE * YES, LIKE THAT *

CVR1: * YES, YES, YOU MAKE A TURN, AND WE WILL GO LIKE THAT AROUND AND THERE *

CVR2: * 47 *

CVR1: * YES *

CVR1: * IF WE CANNOT * 3000, 1009 * OK?

CVR2: * 09

CVR1: * WE ALSO HAVE TO MAKE A CHECK LIST

CVR2: WE ALREADY HAVE IT

CVR1: HA * WHAT IS YOUR TIMING?

CVR2: ONE MINUTE? ONE MINUTE AND SEVEN SECONDS LESS

CVR2: * EXTEND *

CVR2: * ... SLAT EXTEND

CVR2: * ... FLAPS?

CVR1: YOU HAVE THAT? WE ARE HITTING INTO CENTER

CVR2: *

CVR1: * I DIDN'T ALTIMETRE SETTING *

CVR2: * OUT?

CVR1: NORMALLY 40 SECONDS LET'S HAVE SLATS EXTENDED

CVR1: AND FLAPS?

CVR2: ELEVEN * TIME TO OUT *

07.52.15. - JP: We are rolling inbound out of 6000.

07.52.21 - APP: Roger, 1308, report turning inbound.

07.52.25. - JP: Turning inbound to Ajaccio because at the moment we are in clouds.

CVR2: ICING * TEMPERATURE LOW

CVR1: OUT * FOUR * OUTER MARKER STAND BY *

07.52.30 - APP: Roger, 1308 report CT on final, surface wind is 280 degrees 20 kts.

CVR1: * CT, IT IS THIS *

CVR2: * IT IS THIS * YES

CVR1: * WHAT?

CVR2: FIRST * IN AJACCIO *

CVR1: YES

07.53.08. - GPWS: TERRAIN, TERRAIN, TERRAIN

07.53.09. - APP: 1308, it will be as you want left hand circuit runway 21 or right hand circuit.

GPWS: PULL-UP, PULL-UP

07.53.17. - CVR1: POWER

GPWS: PULL-UP, PULL-UP

07.53.20. - ...... CRASH ......

07.55.00. - APP: JP 1308, your position?

07.55.10. - APP: JP 1308, your position?

07.55.23. - APP: 1308 your position please?

07.55.37. - APP: JP 1308, your position?

07.56.00. - APP: 1308, your position please!

07.56.10. - APP: 1308, your position!

07.56.40. - APP: 1308, Ajaccio approach, what is your present position?

07.58.12. - APP: JP 1308, Ajaccio approach!

ANALYSIS AND CONCLUSIONS

- The phrase "it will be for" in the first communication of the approach controller, is not suitable for the issuance of a clearance (like "report descending"

An enlargement of the Jeppessen Approach Chart is included for the purpose of illustration (see also rear cover).

JEPPESEN 26 SEP 80 (11-1) Eff 2 Oct

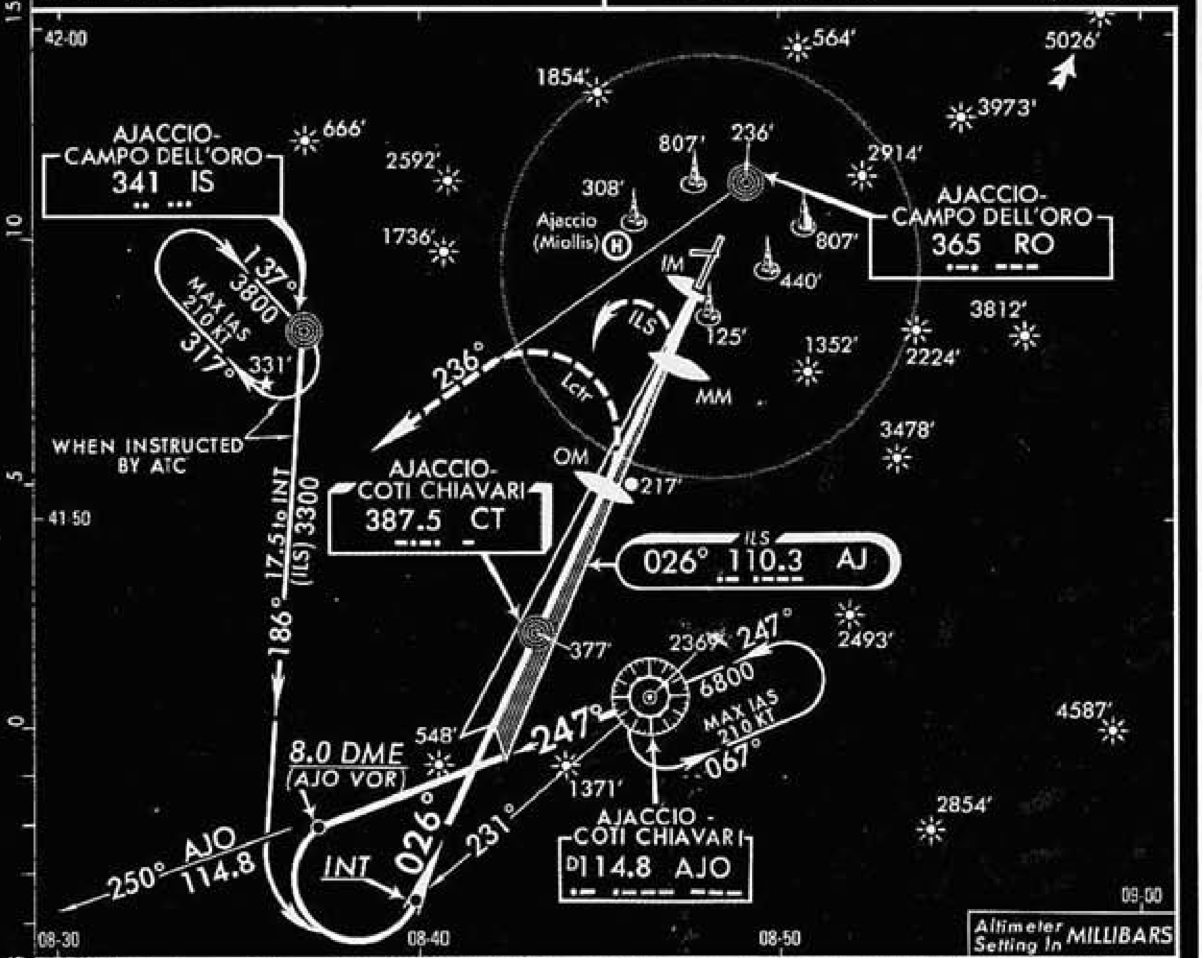
AJACCIO, FRANCE
CAMPO DELL'ORO
VOR ILS Rwy 03
VOR Lctr Rwy 03

LOC 110.3 AJ

AJACCIO Approach 121.05
AJACCIO Airport 118.1
Ground 121.7

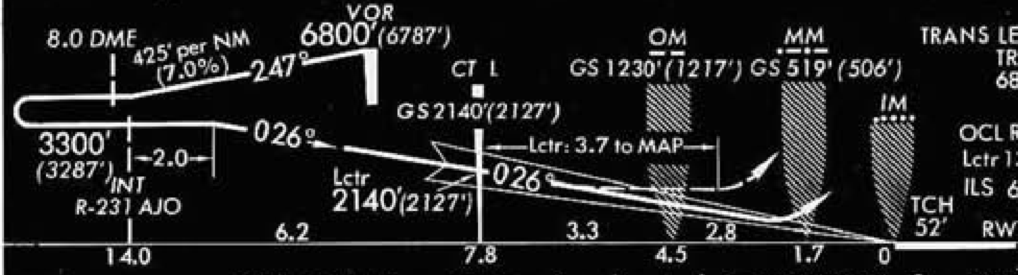
MSA AJO VOR

Apt. Elev 16'



Altimeter Setting In MILLIBARS

NOTE: Final approach based on max 180 KT TAS. Non-precision approach: Descend on final not below ILS glide slope.



TRANS LEVEL BY ATC
TRANS ALT 6800'(6787')

OCL RWY 03
Lctr 1330'(1317')
ILS 643' (630')

RWY 03 13'
APT. 16'

MISSED APPROACH: **ILS**: At MM turn LEFT and as directed. **Lctr**: 3.7 NM after CT L turn LEFT climb on 236° from RO L and as directed.

	STRAIGHT-IN LANDING RWY03			CEILING REQUIRED		CIRCLE-TO-LAND
	ILS		LOC (GS out)	LOCATOR		NIGHT NA ▮CAUTION: High terrain up to 2914' within 3.5 NM of apt.
	DH 656'(643')			MDA 1340'(1327')		
	FULL	MM out				
	CEILING-VISIBILITY				MDA	CEIL-VIS
A	130m- 1250m		NA	270m- 2000m	A 1660' (1644') ▮	500m- 2000m
B *C	130m- 1650m			270m- 2800m	B *C 1760' (1744') ▮	530m- 3000m
D	130m- 2100m			270m- 3200m	D 3320' (3304')	1010m- 4000m

Gnd speed-Kts		70	90	100	120	140	160
GS	2.50°	315	405	450	539	629	719
CT L to MAP	3.7	3:10	2:28	2:13	1:51	1:35	1:23

*ACFT with speed (1.3 Vso) above 135 KT use D minimums.
Without air transport authorization see approach E-21.

CHANGES: See other side.

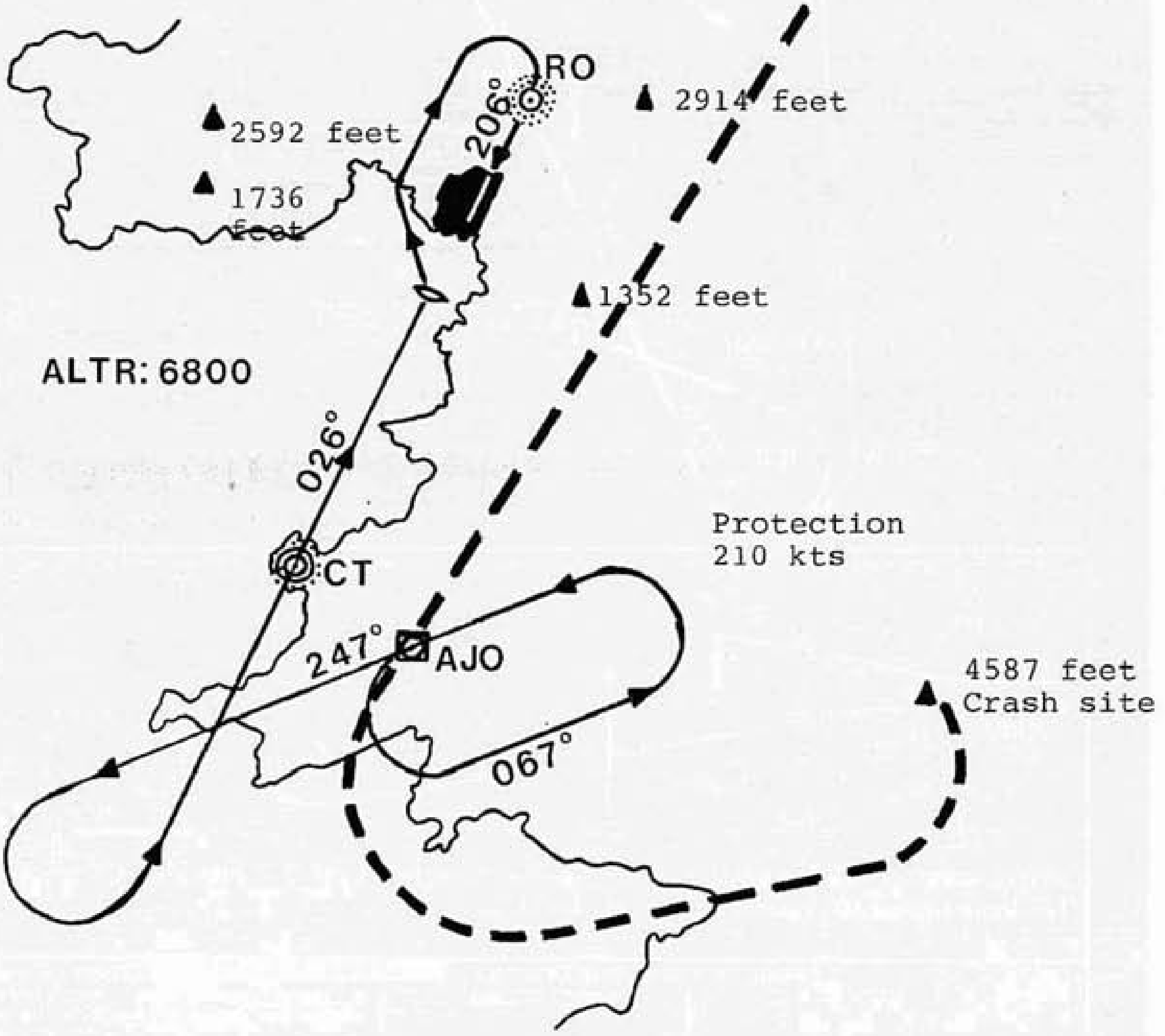
doesn't imply that a clearance for descent has been issued).

- The message "we are leaving 11 for 3000, radial 247" could have made the controller to believe (like he will declare later) that the aircraft had left the VOR on radial 247.

- By saying "we are holding over AJO, call you inbound on radial 247" the pilot probably meant to say "call you inbound (towards the VOR) on radial 247", whereas the controller probably understood "call you inbound (to the field) on (the) radial 247".

- The crew has used the Jeppessen Approach Chart on which the approach procedures and its execution are depicted faultlessly. It is also clearly indicated that AJO VOR should not be overflown at altitudes below 6800 feet. Although the Mt. San Pietro is marked correctly, no additional warning is given with reference to the mountains in close vicinity of the holding pattern.

- Nothing in the Cockpit Voice Recordings indicate that the pilots have paid particular attention to the minimum safe



▬ ▬ ▬ ▬ ▬ Path actually flown by JP1308.

The aircraft started its last turn at an altitude of 6600 feet with a rate of descent of 2200 feet per minute and a rate of turn of 2 degrees per second. From 07.52.26 heavy (increasing) turbulence was recorded until impact.

altitude and the maximum protection speed.

- Investigation of the R/T recordings has revealed that:
  (a) many misunderstandings arose from the use of abbreviations and incorrect ambiguous language,
  (b) the controller could not follow the progress of the flight and did not realize that he misunderstood the messages from JP 1308.
- The clearance to descend to 3000 feet was in accordance with the existing rules.
- The crew might have given a wrong interpretation to the term "radial 247", by including the route segment which extends to the north-east of the VOR and marked with 247°.
- The pilot did not initiate an avoiding manoeuvre at once after intervention of the GPWS alarm. The GWPS gave ground proximity warnings for 13 seconds before the left wing collided, in a turn, with the summit of the mountain. The insufficient attempt to reduce the vertical speed or even to regain altitude was, in addition, hindered by downdraughts in a zone of turbulence.
- Except when the aircraft is proceeding on radar vectors, it is the pilot's responsibility to provide separation with the terrain.
- When overflying the AJO VOR the indicated airspeed was greater than the maximum protection speed of the holding pattern. Adjustments to the wind were not appropriately applied.

<u>CAUSES</u>

- The descent under instrument conditions below the published minimum safe altitude.
- The attempt to regain altitude was insufficient in view of the downward currents in a mountainous area with strong winds.

<u>OTHER FACTORS</u>

The investigators indicated that a concurrence of other circumstances have contributed to a situation which the crew could not master anymore:

- The crew did not apply enough precision during the approach and moreover, the presence of a child in the observer's seat distracted the crew's attention.
- Misapprehension brought about by ambiguous pilot/controller communications could have interfered with the crew's vigilance. The controller did not have an accurate indication of the flight's progress and did not intervene when the pilot reported "call you inbound on radial 247" and then "rolling inbound out of 6000". If those calls would have been interpreted better, it could have indicated the ambiguity of the first situation and that an abnormal and dangerous situation existed after reception of the second message.

- The custom to issue clearances which take into account the minimum safe altitude could be a motive for some pilots to take less account of these safe altitudes.
- The Jeppessen chart depicts a holding pattern flown under no wind conditions with a speed of 150 knots. In reality the dimensions of the pattern would be much greater if the aircraft proceeds at higher speeds.

RECOMMENDATIONS

1. Training programmes of flight crews should stress the need for methodical reviews of procedures in the take-off and the approach phase.
2. The implementation of standard phraseology to prevent misunderstandings should be accelerated.
3. The term "RADIAL" still leads to misapprehension.
4. It is dangerous to employ the terms "INBOUND" and "OUTBOUND" on their own.
5. Flight crews should be reminded that approach clearances don't take account of minimum safe altitudes (except when radar vectors are given).
6. Controllers and pilots should be familiar with each others' working conditions. FAM-flights should be encouraged and included in training programmes.
7. The approach procedures of Ajaccio have to be reviewed in order to allow for an approach executed over sea.
8. Design and symbology of approach charts should be reexamined. Presently approach charts do not provide a true presentation of the area covered by an aircraft flying at maximum protection speed. The highest obstacle should be marked with an appropriate symbol.

Philippe Domogala

Instilux - 2 Simulator

by Jerry Watson

Since 1970, the EUROCONTROL Institute in Luxembourg carries out training in all areas related to Air Traffic Control (ATC) such as basic and advanced controller training, technical training for engineers on current and future ATC equipment, and courses on the introduction of computers and programming into ATC services. The latter is particularly relevant as the Institute itself installed, in 1971, a computer and display system, the Instilux-1 simulator, so that ATC controller training could be made under simulated control room conditions. Since then the simulator, representing the "heart" of the Institute's training programme, has supported instructor and management training courses.

Since the early days the Institute has developed its training program to keep up with requirements and the developments generally taking place in the ATC field. New courses were introduced some of which were developed, using the Simulator, in order to teach not only basic but also advanced ATC control procedures. Here special simulation exercises were introduced in order to teach particular skills, involving computer-aided-instruction (CAI) techniques.

After more than 10 years use of the computer and display hardware, the original simulator is fast approaching the end of its useful lifetime. The technology, capacity and flexibility, both software and hardware, no longer correspond to todays standards.

In the framework of the long term planning for the Institute it was therefore decided in 1979 to re-equip the Institute with a new computer and Input/Output equipment and moreover, in order not to perturb the course program, to house the new equipment in an annex to the main building. This annex also has a separate Simulation Room and airconditioning facilities.

The Call-for-Tender for the new equipment was started in 1980 and in September 1983 the first phase of the hardware installation was terminated. This included the main computer complex and two test-and-development positions upon which the preparations for software production was started. A second phase takes place in spring '84 when 6 completely equipped working positions will be installed in the simulation room and in spring '85 the final hardware delivery of 6 further working positions will be made. The target date for first release of the Simulator for operational evaluation is February 1986.

Before describing in more detail what the essential characteristics of the new Simulator, Instilux-2 with respect to Instilux-1 will be it should be briefly described what an ATC simulator does.

The principle purpose of an ATC simulator is to present to a trainee controller a working environment as similar as possible to the real-life environment to be found in an ATC control centre. Such an environment for an individual controller consists of 4 items:

1. the working position at which he sits, with the relevant hardware devices, e.g. Radar Screen (SDD), Tabular Display (EDD), Touch Input Device (T.I.D.), Keyboard (KYB), Display Control Panel (DCP) and Rolling Ball (RLB),
2. the means of communication with adjacent working positions,
3. the facilities allowing him to display in various forms, data concerning aircraft he is controlling, and
4. the means of communication with aircraft under his control.

Items 1), 2) and 3) can be installed in a simulator as they are in any control centre. However item 4 is where an ATC simulator diverges from real-life. A trainee controller cannot communicate with a real aircraft pilot; he must communicate with a "Simulator Pilot" located in the same room as the trainee and sitting at a similar working position to his own. In addition, the data which the trainee can see, concerning an aircraft, do not come from real radar responses or real flight plans. Instead they are derived from prepared data contained within Simulation Plans and kept dynamically updated. They can then be displayed in as close a representation as possible to that seen in a normal control centre.

The simulator pilot and the simulator programs therefore combine, in order to give the trainee a picture of the air traffic situation as realistically as possible.

The trainee is not working alone but within an airspace environment involving traffic, adjacent working positions, "pilot" positions and data describing the airspace region. This environment constitutes what is called a simulation exercise which is run over a given time period (normally lasting between 30 minutes and 2 hours).

In live systems the majority of improvements made concern the working procedures, data processing and display functions within the centre. The traffic flow, the airspace structure and the adjacent working environment for a controller suffer few modifications. For an ATC simulator of the type used in Luxembourg the opposite is true. The individual controller actions are more important than the overall intercentre working procedures and traffic plan and airspace descriptions have to be modified frequently to comply with various customer and instructor requirements.

The new Instilux-2 simulator, therefore consists of the following elements.

1. The main computer complex (MCC) providing the main computing power.
2. The display computer complex consisting of 12-14 working positions each containing a computer, called a working position processor (WPP).
3. The telecommunication system simulating Air-Ground and Ground-Ground communication links.
4. The programs, or software, which run in MCC and WPP computers.

Below is a schematic diagram of the Instilux-2 hardware configuration.

The Instilux-2 Main Computer Complex (MCC) consists of a VAX 11/780 from DIGITAL Equipment Corporation (D.E.C.) with 2 Megabytes of main memory and 256 Megabytes of disc memory. The computer is classed in the category of "large mini" and has approximately the computing power of one of the main computers in a live centre. A computer of this category was chosen not only for its high computing capabilities but also because of the extensive range of standard software available for a variety of uses.

The display complex as can be seen from the diagram consists of fourteen working positions, each consisting of a number of peripheral devices.

The two Test and Development positions have standard peripherals to allow efficient program production activities. Apart from this all 14 working positions are fitted with the same peripherals and the same display computer, i.e. D.E.C. PDP11/23+. This computer belongs to the small mini or microcomputer class and because of its Input/Output facilities it is suited to tasks such as the collection of inputs and display of output data to and from a wide range of peripherals using proven standard software

for task scheduling and resource management.

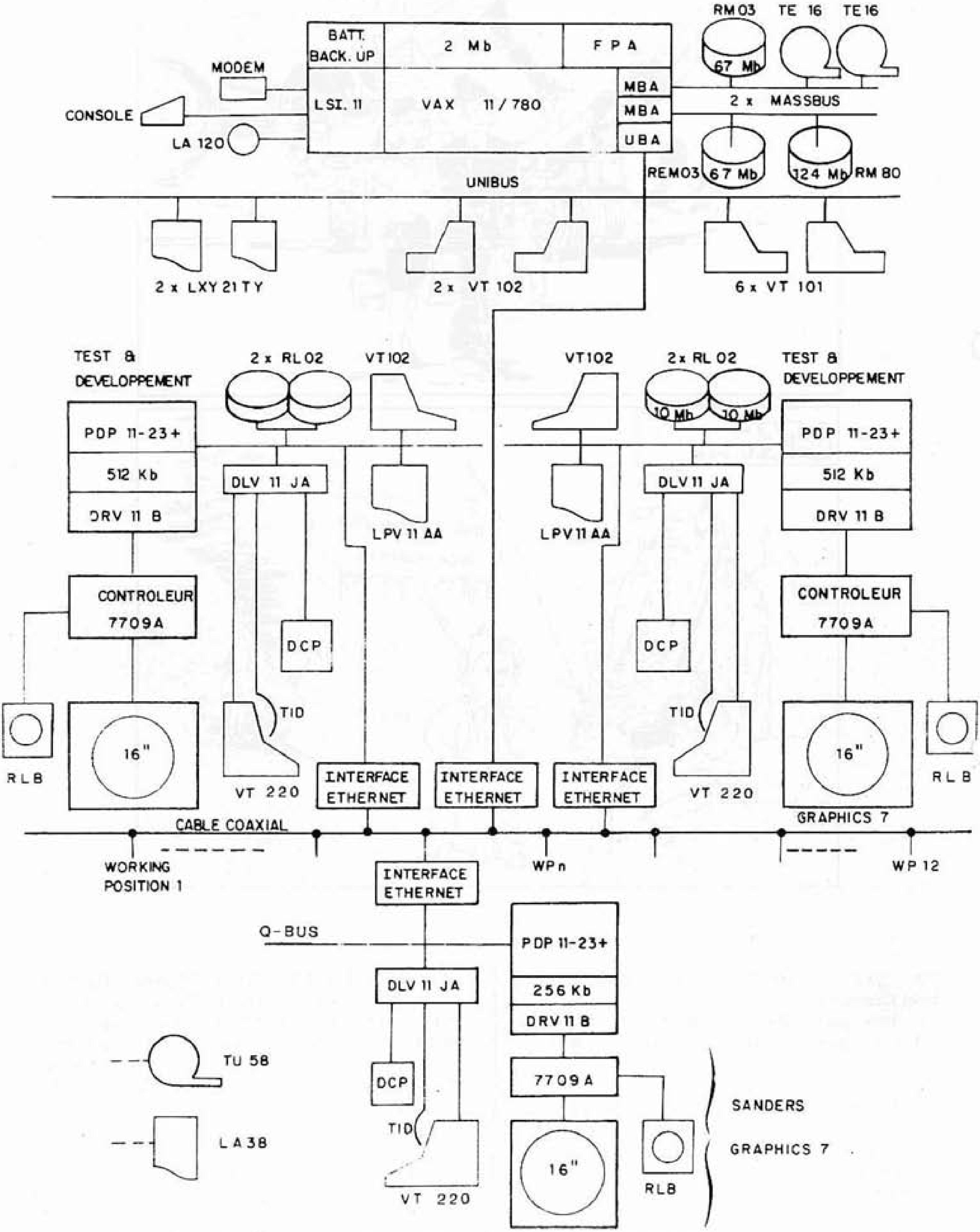
The peripheral devices attached to each display computer are those typically found in live systems, namely:

1. An Electronic Data Display (EDD) allowing the display of tabular data to a maximum of 24 lines of 80 characters (D.E.C. VT220).

2. A keyboard. This keyboard, together with the EDD, form a standard input terminal unit. However, the keyboard in Instilux-2 is planned to be used as a supplementary input device to the TID below.

3. A Touch Input Display mask (TID), (SORED, France). This device consists of a plastic "screen" which is stuck on to the

Configuration INSTILUX 2



surface of the EDD screen. If touched by a finger or any other object anywhere on its surface, an attached microprocessor generates the x,y coordinates of the touched point and sends them to the WPP. It has a high precision and has the advantage over the conventional fixed wire touch devices that the touch sensitive areas can be controlled by software and adapted to any relevant display format. On conventional devices the inverse is true, i.e. the display format has to be adapted to the fixed position of the limited number of wires or touch points. Because of its flexibility this device is going to be used as the primary input device at simulator working positions.
4. A display control panel (DCP), (BECKAERT, Belgium) which is a function keyboard to be used in conjunction with the SDD below. It contains 36 buttons, each containing a lamp which can be activated by software. Software functions are allocated to the buttons which enable working positions' operators to modify, by a single action, the status of the data displayed on the SDD.
5. A Synthetic Dynamic Display (SDD), (Graphic 7 from CALCOMP-SANDERS) upon which the computer generated traffic situations will be visible in raw and/or synthetic video form. This display device contains its own programmable microcomputer and picture repetition memory of 16K Bytes. The high I/O load for the repetitive output of data is therefore transferred from the WPP to the SDD itself.
6. A Rolling Ball (RLB) is linked to the SDD. It is used for the designation of Plots and Tracks etc. on the SDD. The x,y coordinates will be requested by the WPP when required.

The Main Computer is linked to all WPPs by an ETHERNET local communication network. Such a link represents the latest state of the art in local intercomputer connections. It is a highspeed link enabling individual and broadcast message transfer and allowing sim-

The Instilux-2 computer centre.

plified software communication logic within the Main Computer and Working Positions.

The ETHERNET concept is at present being standardized at an international level and this together with the fact that the majority of the Instilux-2 equipment, described above, is widely used off-the-shelf technology, guarantees a satisfactory degree of flexibility for the future.

The telecommunication system (MBLE, Belgium) allows at each working position a ground-ground communication link with up to 12 other working positions and an air-ground communication link on one of three frequencies. The telecommunication system is microprocessor controlled so that setting up can be made either manually using a specially designed command language or automatically from the main computer complex.

The programs which will execute in the MCC and WPP computers reflect the requirements expressed by the customers. It is here that we have to describe the difference between the operational characteristics of the Instilux-2 and the existing simulator.

The first requirement for Instilux-2 is that its operational capabilities should be the same, if not then similar, to those of Instilux-1. These can be perhaps summarized as follows:

1. capable of simulating 60 aircraft simultaneously
2. simulation of 2 radars
3. 6 controllers and 6 pilot positions
4. display of traffic in raw video or synthetic form
5. capable of allowing various types of simulation exercises, viz. Global, Individual, Computer Aided Instruction
6. limited flight plan processing capability
7. simulation of Meteorological conditions.

It should be noted that at the time the Instilux-1 simulator was implemented the widespread use of computer aided Air Traffic Control was in its infancy. Since then the methods and terminology in both Flight Plan and Track processing have developed. The Instilux-2 application package will reflect these developments. In particular we should mention:

- multiradar tracking
- automatic code allocation
- sectorization
- controller - computer conversations.

Therefore for the experienced simulator operator the only difference that should be noticeable is that the traffic behaviour and the operator-computer interfaces resemble reality more than in the past.

The second requirement for Instilux-2 is that, for staff managing simulations such as Instructors, Data Preparation Staff and 'Pilot' operators, the system should be far more "user-friendly" than in the past and here it is intended to make full use of the inherent hardware and standard software flexibility available.

The user friendliness of Instilux-2 will be improved with respect to the previous simulator in the following areas:

1. The preparation of data for simulation exercises.
2. The set-up procedure at exercise start time.
3. The freezing and replaying of exercises.
4. The post exercise analysis of simulations.
5. The 'pilot' operator inputs.
6. Concurrent execution of production and simulation tasks.

In the past the preparation and management of the large amount of data necessary for an exercise was handicapped by the limitations of the hardware and software available. Some of the Instilux-2 improvements in the data preparation area will be:

a) Preparation data processing can be made whilst simulation exercises are taking place instead of before or afterwards as in the past.
b) Two types of data preparation input can be made, the so-called 'mass input' designed for the input of large amounts of data by experienced input operators and the 'conversational' input designed for the use of users such as instructors who wish to modify single elements of a particular data file infrequently.
c) The extension of data preparation to include limited simulation facilities so that traffic definition can be validated during preparation without involving a full scale simulation exercise.

The new preparation facilities involve the extensive use of the D.E.C. standard software packages Common Data Dictionary (C.D.D.), DATATRIEVE and Forms Management System (F.M.S.). Both DATATRIEVE and FMS have standard software interfaces for use with D.E.C. PASCAL, the programming language being used for the production of all application software.

The set-up procedure at exercise start time will be improved such that the configuration of working positions can be chosen by the instructor, as well as which traffic samples are to be used. Here, due to the fact that all working positions have the same equipment and that several exercises may run in parallel, it will be possible for the user to select a convenient subset of working positions rather than sticking to a fixed configuration as in the past.

Functions which improve the educational use of a simulator in training are the freeze, backstep and replay functions in order to examine behaviour or to correct mistakes. Such functions are only useful if they are fast and efficient to use and they will be designed accordingly in Instilux-2.

An important post-simulation activity is analysis of results. The facility of data collection for analysis is only used in Computer Aided Instruction (C.A.I.) simulations at present. This concept will be extended in Instilux-2 such that continuous data recording coupled with appropriate analysis and print programs will enable post simulation analysis of all significant events.

The pilot operator inputs foreseen for Instilux-2 represent a departure from the classical keyboard input method in that they will be designed around the use of touch input trees, using the new touch masks overlaying the EDD. Here we expect an overall improvement of "Piloting" actions due to the improved flexibility of the hardware and backing software.

In the past the limiting capacity of the Instilux-1 computer prohibited the concurrent execution of program production and simulation tasks. Even different types of simulation exercises could not run concurrently. However, due to the increased power and standard software facilities of the VAX 11/780, it will be possible to run both simulations and various other production tasks simultaneously. It will thus be possible to approach the software production efficiency of those centres which have a separate standby system available for production. The size and capacity of Instilux-1 prohibited this in the past.

In conclusion, the Instilux-2 system when entering operation in 1986 will offer a range of improvements for both students and instructors as well as represent in both hardware and software a powerful enough configuration to enable us to keep abreast of developments in real A.T.C. centres.

An Aircraft Encounter with a Tornado

This report written by W.T.Roach and J.Findlater (Meteorological Office, Bracknell) was published in the Meteorological Magazine in February, 1983 (Vol. 112). Evidence is presented which supports the claim that the loss of an aircraft near Rotterdam was due to an encounter with a tornado. The discussion of the associated meteorological situation is not reprinted in total, nor is the computation of the probability of an encounter with a tornado included. Permission to reproduce this article was granted by the controller of Her Majesty's Stationery Office, Norwich.

1. Introduction

At 1604 GMT on 6 October 1981, a Fokker F-28 aircraft (PH-CHI) took off from Rotterdam en route to Eindhoven. There were thunderstorms in the area and the aircraft, flying at 3000 ft (900 m), entered one of them a few minutes after take-off. After a short period of moderate turbulence in

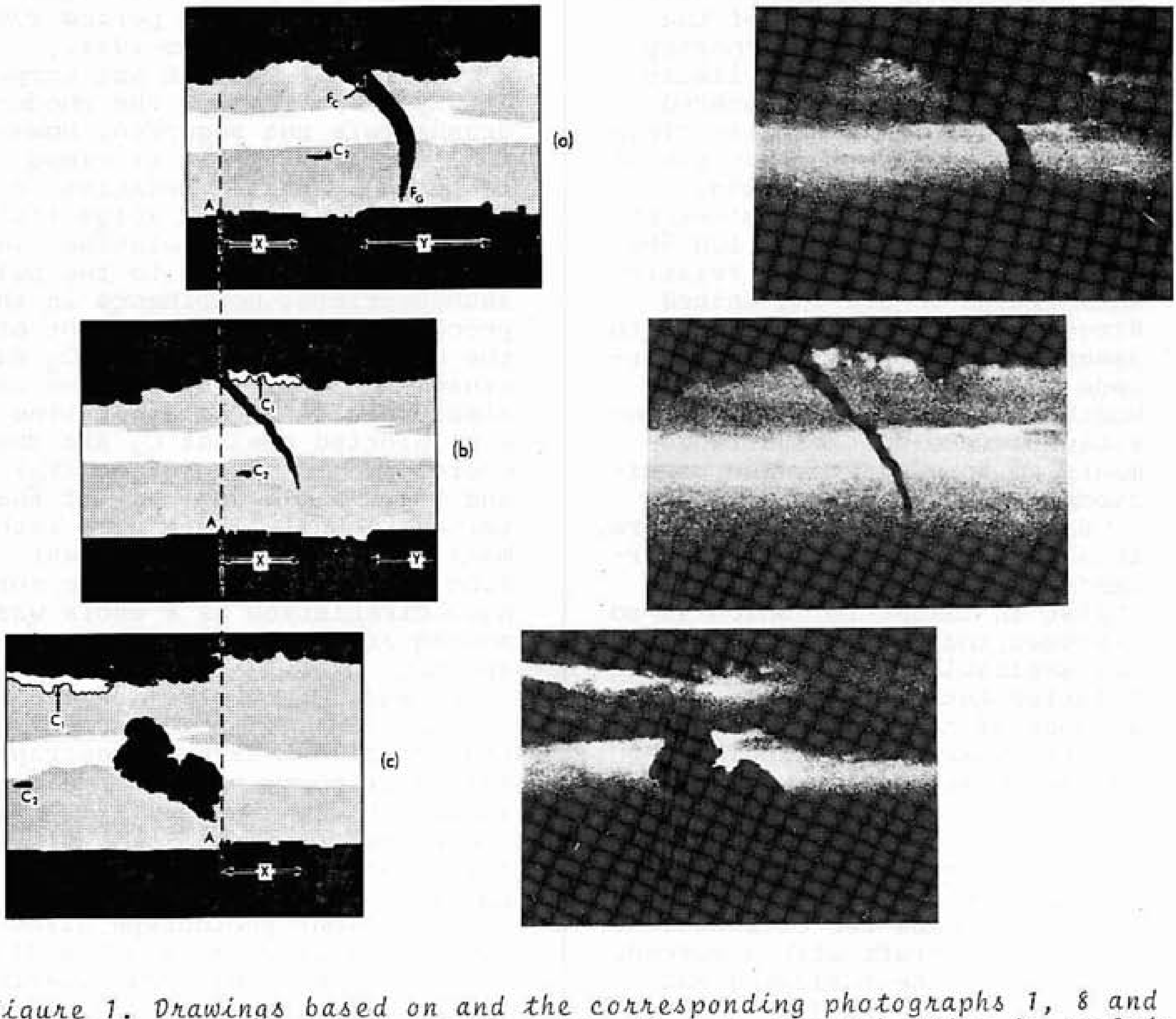


Figure 1. Drawings based on and the corresponding photographs 1, 8 and 16 of the series taken from the police launch. The labelling is explained in the text. Fig. 1(c) shows the cloud of smoke ejected from the aircraft crash.

cloud, the aircraft suddenly encountered extreme turbulence in which the starboard wing was detached and, at 1612 GMT, the aircraft crashed near Moerdijk, about 25 km south-south-east of Rotterdam, with the loss of all occupants.

It soon transpired that a tornado was reported just west of Moerdijk a few minutes before the crash, and in fact a police launch travelling east along the Hollandsch Diep had not only taken a series of photographs of the tornado, but also - less than a minute later - of the cloud of smoke rising from the aircraft impact explosion. This, together with other evidence provided by the Director of the Aeronautical Inspection Directorate of the Dutch Civil Aviation Authority showed that it was very likely that the aircraft encountered the tornado circulation in cloud shortly after the tornado funnel had lifted from the ground.

The flight safety implications raised by this incident led the Dutch and British Civil Aviation Authorities to ask the United Kingdom Meteorological Office to assess the probability of a tornado encounter in flight, and whether it was necessary or possible to make special arrangements to forecast tornado conditions.

Since, as far as we are aware, this is the only case of an aircraft encounter with a tornado whilst in flight for which it so happened that adequate evidence was available, the Dutch Civil Aviation Authority agreed that an account of the incident should be published after the findings of the official enquiry were released.

2. <u>The evidence for tornado encounter</u>

The evidence for encounter of the F-28 aircraft with a tornado is based on the following material kindly provided by the Dutch Civil Aviation Authority:

(a) Fifteen prints of the Moerdijk tornado and two prints of the aircraft explosion cloud taken by a police launch on the Hollandsch Diep. (See Fig.1.)

(b) Two colour prints of the same tornado from another site a few minutes earlier.

(c) A 1:10 000 scale map of the Moerdijk area indicating the aircraft track, the location of the police launch and the position from which the colour photographs were taken, with direction lines. Also indicated is the tornado track based on surface damage. (See Fig.2.)

(d) A copy of the flight record recovered from the aircraft wreckage. (See Fig.3.)

(e) Hourly maps of radar echo distribution for the period 1300-1700 GMT on 6 October 1981.

Unfortunately, but not surprisingly, the times of the photographs were not recorded. However, the lateral movement of cloud features C_1 and C_2 relative to a fixed ground point A (Figs 1(a) and (b)) enabled a relative time scale to be assigned to the police launch prints. Confidence in this procedure is given by a plot of the coordinates of C_1 and C_2 against each other which shows an almost perfectly straight line. Also plotted against C_2 are the coordinates of the bottom (F_G) and the visible top (F_C) of the tornado funnel. These show rather more scatter about a straight line, but indicate that the tornado circulation as a whole was moving at a roughly constant speed.

C_1 and C_2 are also identifiable on the prints of the aircraft explosion cloud. Backward extrapolation of the two explosion cloud images enables a time of aircraft-ground impact to be located on the relative time scale within fairly narrow limits.

The colour photograph direction lines drawn on the Moerdijk map yield an angular calibration on these photographs of 0.037 radians per centimetre from which it appeared that the width of the tornado funnel near cloud base was about 100 m and decreasing, and the height of cloud base was about 400 m. The tornado damage path indicated in the map was over 300 m wide and showed that the funnel cloud marks the centre of a much bigger circulation.

There were no direction lines drawn for the police launch photographs, and it proved difficult to identify surface features appearing on the prints with those on the map. However, the images of the tornado and associated cloud are of similar size on both colour and police launch photographs, and were taken from a similar distance (about 2 km). Using this fact, it appears that building complexes X and Y on the photographs (Fig. 1) were probably those marked X and Y on the map (Fig. 2), and this has been assumed in the subsequent analysis. The point A marking the left of the building complex X on Fig. 1 was directly in line with the aircraft impact point, and is thought to correspond with the point A on Fig. 2.

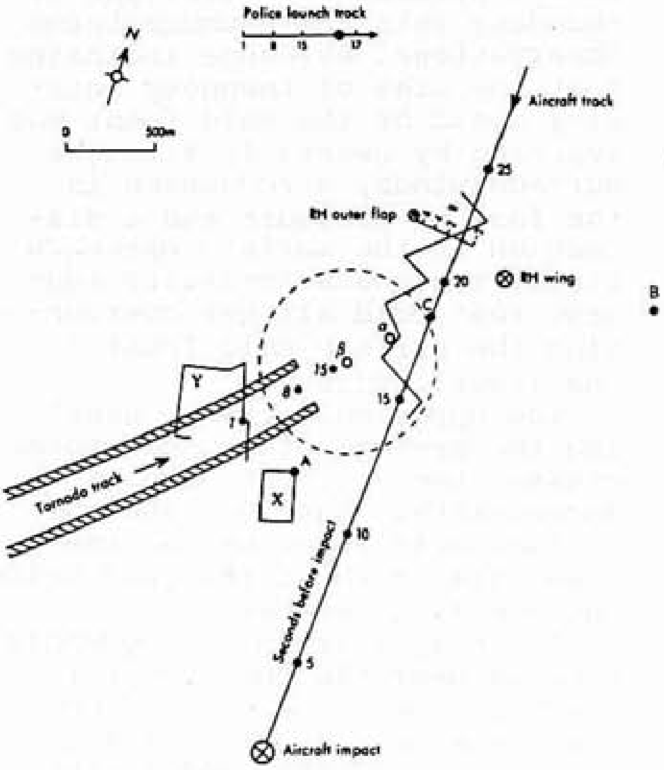


Figure 2. Sketch map of tornado and aircraft tracks. Labelling explained in the text.

The location of the centre of the tornado circulation at the time of aircraft-ground impact is estimated to lie near a on Fig.2.

Evidence from the flight recorder, (Fig. 3.) has been used to estimate the location of the aircraft along its track at 5-second intervals relative to time of impact as marked in Fig. 2. The accelerometer record has been superimposed on the aircraft track in Fig. 2. The main 'g-spikes' are close to the intersection of the aircraft track with the projected tornado track (C in Fig. 2.) about 18 seconds before impact, and to the position of impact of the starboard wing and flap, while the disturbance in which the g-spikes are embedded appears to have affected about 1 km of the aircraft track. However, C appears to be ahead of the estimated centre of the tornado circulation (a) when the aircraft crashed 18 seconds later.

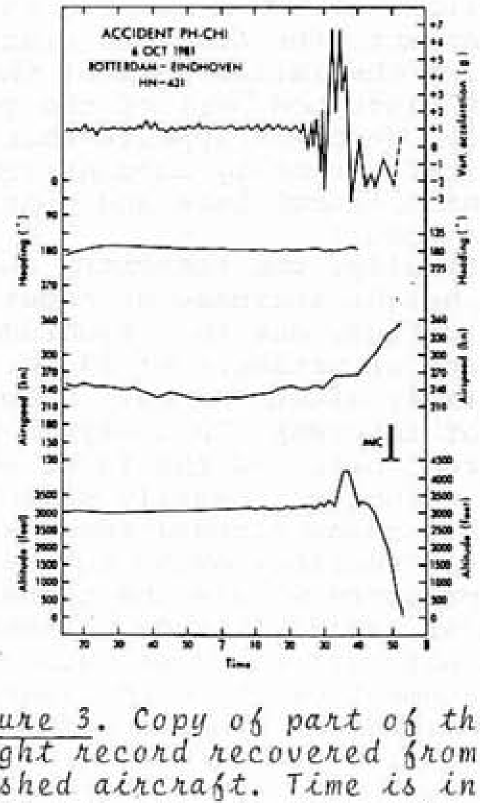


Figure 3. Copy of part of the flight record recovered from the crashed aircraft. Time is in minutes and seconds from take-off.

The location of this circulation at the time the aircraft was at C cannot be directly estimated as the speed of the tornado is not known and the relative time scale has not been calibrated. However, there are indirect indications:

(a) The sequence of radar pictures (one of which is shown in Fig. 4) show that the storm complex which passed over the site of the accident was moving north-east at about 20 m/s. It is likely that the tornado circulation was being carried by the storm complex at about the same speed.

(b) Reference to Fig. 2 shows that the funnel cloud was moving about 50% faster than the police launch. The inferred speed of 13 m/s for the police launch seems fast if photographs were being taken from it, but it may have been trying to 'keep up' with the funnel. We consider that the speed of translation of the tornado circulation was about 15 m/s.

The estimated position of the centre of the tornado circulation when the aircraft was at C (Fig. 2) is probably within 200 m of B. A circle of 500 m centred on B intersects the aircraft track during the latter part of the most disturbed part of the g-trace. Hence it appears that the aircraft probably encountered the tornado circulation and crashed as a result.

Finally, the temporary indicated height increase of about 300 metres, due to a recorded decrease of pressure of 29 mb, immediately after the main g-spike is of interest. This may be partly real owing to the large vertical velocities usually associated with tornado circulations, and partly spurious owing to the drop of pressure within the tornado and/or rapid altitude changes of the aircraft after or during the detachment of its wing creating anomalous aerodynamic effects at the altimeter orifice.

3. The meteorological conditions

At 1200 GMT on 5 October 1981 a small depression was approaching the north of Ireland from the west whilst a diffuse warm or quasi-stationary front lay close to the line Lisbon-Paris-Cologne. A depression west of Portugal induced a wave on the front which developed and moved north-eastwards to become centred in the English Channel by 1200 GMT on 6 October. Meanwhile the associated warm front advanced northwards across Europe, passing over most of the Netherlands between 0600 and 1800 GMT. The cold front of the same depression moved quickly across the Bay of Biscay and France, and passed over the Netherlands between 1500 and 2000 GMT.

Subsequently, the wave depression moved over the North Sea and amalgamated with the Atlantic depression which had become slow moving near the north of Scotland.

By 1500 GMT rain associated with the warm front had cleared from the Rotterdam area which was then covered by a light southerly flow of warm moist air with dew-point temperatures of 15-16°C. The cold front was advancing rapidly from the west at about 26 m/s preceded by outbreaks of thundery rain and thunderstorms. Observational evidence indicates that the area of thundery activity ahead of the cold front was typified by generally stronger surface winds, a reduction in the fall of pressure and a distortion in the surface pressure field. The characteristics suggest that cold air was overrunning the surface cold front in the lower levels.

The upper cold front, heralding the arrival of thunderstorms, crossed the accident site at approximately 1545 GMT and the surface cold front passed the same site at about 1640 GMT bringing clearing weather.

The only relevant autographic records near the observed tornado track or the scene of the accident were from an anemograph situated at an air pollution monitoring station at point B in Fig. 2. A reproduction of the records of surface wind direction and speed is shown in Figs. 5(a) and (b).

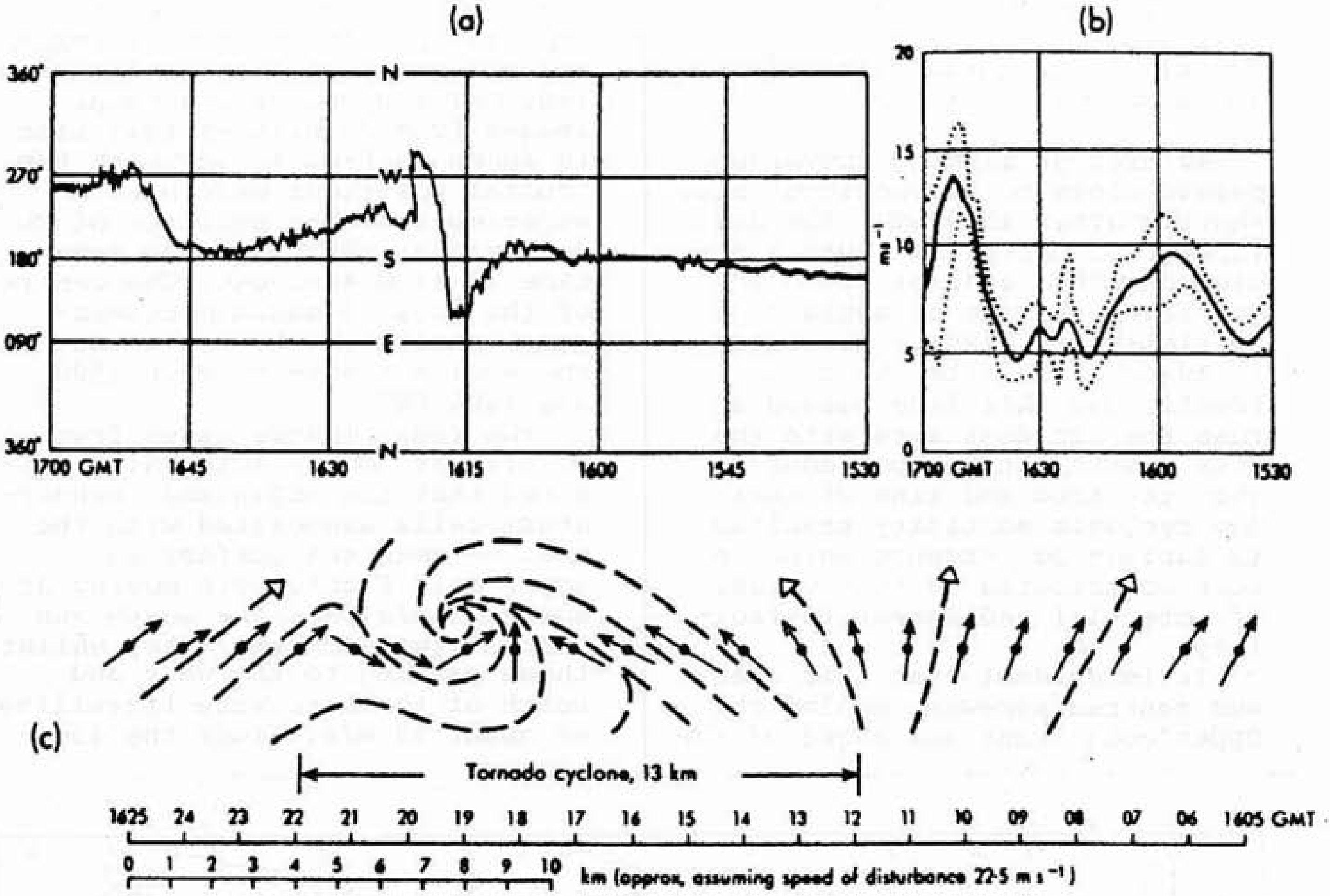


Figure 4. Anemogram traces (a), (b) from air pollution monitoring station at Moerdijk on 6 October 1981 and the deduced airflow (c) in the vicinity. The site of the anemometer is at point B in Fig. 2.

The record shows increasing wind speeds between 1535 and 1545 GMT with a gradual veer of surface wind from east of south to a little west of south, probably due to the downward transfer of momentum from the increasing south-westerly winds above the surface as the upper cold front passed. A second increase in wind speed occurred between 1640 and 1650 GMT and the wind veered to a westerly at 1650 GMT as the surface cold front passed. Between these two events lighter surface winds of about 4-7 m/s obtained and marked directional changes took place. These directional changes are analysed in Fig. 5(c) and sketched streamlines suggest that a tornado cyclone passed the station between 1612 and 1622 GMT disturbing the generally south-westerly wind field, and that a cyclonically rotating vortex passed a few hundred metres to the north of the anemometer site at 1619 GMT. It has been shown earlier that the aircraft intercepted the tornado circulation in cloud within a minute of 1612 GMT when the tornado funnel had lifted from the surface. The assumed speed of that tornado, though dissipating at the surface, would have placed it a few hundred metres to the north of the anemometer site at about 1613-1614 GMT some 5-6 minutes earlier than a vortex was deduced to have passed there. However, there may be an error in the timing of the anemograph record or there may have been more than one tornado or vortex in the wider area of the tornado cyclone. Indeed, eyewitnesses, and one photograph, give evidence of two tornado funnels in the area just before the accident.

An area of maximum convergence passed close to the accident site shortly after 1500 GMT. The development of convergence was associated with a zone of cyclonic vorticity. A line of maximum vorticity can also be discerned in association with the cold fronts, and this line passed across the accident site with the cold fronts. It can be deduced that the area and line of maximum cyclonic vorticity resulted in surface convergence which in turn contributed to the release of potential and latent instability.

It is evident that this area was centred somewhat behind the upper cold front and ahead of the surface cold front. The centre of the area passed between Rotterdam and the accident site at about 1600 GMT and one of the radar images from De Bilt at this time is shown in Fig. 4, on which the frontal positions have been superimposed. The position of the jet axis at 850 mb at the same time is also included. The centre of the area of maximum convergence passed to the south-east of the accident site between 1500 and 1600 GMT.

The radar images taken from De Bilt at hourly intervals indicated that the organized thunderstorm cells associated with the area between the surface and upper cold fronts were moving at about 25 m/s past the south and east of the accident site, whilst those passing to the west and north of the site were travelling at about 17 m/s. Since the acci-

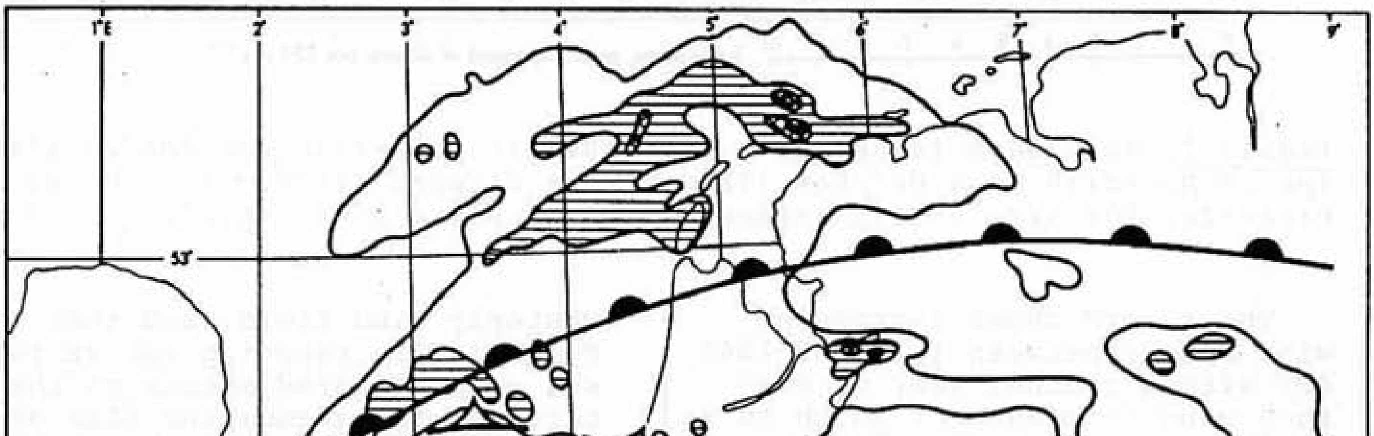


Figure 5. Radar images of rain areas recorded at the De Bilt at 1600 GMT on 6 October 1981. Frontal positions and the jet axis at 850 mb are superimposed.

dent site lay on the northern flank of the jet axis at low level in the zone of pronounced cyclonic shear, and hence in a region of cyclonic vorticity, upward motion and the subsequent release of latent heat and potential instability would further locally intensify the low-level convergence and lead to the concentration of cyclonic vorticity with which tornadic storms are associated. In these circumstances tornado cyclones form, with diameters typically of 5-40 km, and may contain one or more actual tornadoes.

It was reported that a hook-shaped radar echo was visible on a photograph of the De Bilt radar image at 1600 GMT in the southern part of the large echo which adjoins the accident site in Fig.4. Hook-shaped radar echoes have often been reported in the United States just prior to the appearance of surface tornadoes, and the dimension (along the wind) of 13 km of the tornado cyclone deduced from Fig. 5 and the dimension (across the wind) of 14 km of the swath of damage of tornado funnel sightings at Moerdijk, Hellegatsplein, Ridderkerk and Puttershoek to Hendrik Ido Ambacht, provide very strong evidence of the presence of a tornado cyclone on this occasion.

It may be concluded that the air mass between the surface and upper cold fronts was favourable for the development of severe convective storms, and it was especially so in the area bounded in the south by the axis of the jet stream at 850 mb and in the north by the coastline on the edge of the strong upper winds 850 mb.

4. Estimated probability of aircraft-tornado encounter

Climatological tornado statistics in the United States are used to estimate the frequency of encounter in the "worst" tornado areas. The low-lying areas of France and Germany are climatologically not very different from south-east England, and therefore it is assumed that tornado occurrence over south-east England is fairly representative of much of that over the low-lying parts of north-western Europe.

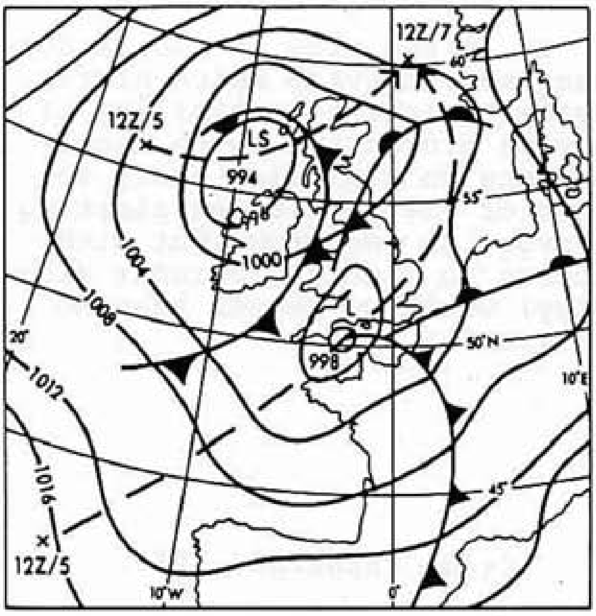


Figure 6. Synoptic situation at 1200 GMT on 6 October 1981.

From extensive and thorough analysis it is concluded that the annual frequency of reported tornadoes in the United Kingdom is comparable to the worst area of the United States, but U.K. tornadoes are rarely of high intensity.

Based on surface damage area an aircraft encounter frequency of the order of once per 10^8 flying hours is likely. There is some evidence that the most intense circulation in a developed tornado occurs 100-200 m above the ground, and above this the vortex widens and the wind speeds decrease somewhat. It is suggested to increase encounter frequencies by a factor of 3 to take crude account of this phenomenon.

Severe storms in north-west Europe are too rare to warrant a special severe-storm forecasting service on the United States pattern, but there may be some merit in forecasters acquiring some familiarity with synoptic and radar features associated with severe storms.

It is the view of the authors that some service which alerts aviation to the possibility of severe storms and which might operate on a similar basis to that of the wind shear alerting service at Heathrow (but with access to a suitable radar display) would be better than no service at all.

THINGS THAT HAPPEN AT SEA.

The fate of the coaster "ROYAL TAR". She steamed out of St. John New Brunswick for Maine in 1836, carrying a complete circus and two side shows, Dexters Locomotive Museum and Burgess's collection of serpents and birds. Off Fox Island the ship caught fire. Resourceful passengers ripped up deck planking and lashed together a raft.

When they were aboard it in the water, an elephant jumped on top of them!

Another passenger dragged his trunk on deck, removed five hundred silver dollars and put them in his money belt. He threw the trunk over the side and dived in after it. The trunk floated!

Collision at Sea

by Rob Bootsma

Under a similar title Dr. Willem Albert Wagenaar, associated with the "Instituut voor Zintuigfysiologie TNO" at Soesterberg, produced an article in the Dutch magazine "Psychologie", June 1982. It is observed that accidents seldom originate as a direct consequence from one single error, but result from an accumulation of minor inadvertent faults committed in our daily lives. Another article in "NRC-Handelsblad" of 24th November, 1983 indicates that the avoidance of accidents, incidents or mistakes requires an accurate risk-analysis beforehand. Even when the precise sequence of events is known, it is difficult, if not impossible, to pin-point the sole cause leading to an occurrance.

The following intends to bring these articles to a synthesis. I am grateful to Dr. Wagenaar who has kindly given his permission to use and translate some of his material for an article in INPUT. The names of persons and ships are fictitious.

Preliminary.

Four per cent of the Dutch population don't die from natural causes but perish in fatal accidents. In 85 per cent of these cases people have to blame either themselves or someone else. De facto human errors occur very frequently: in the majority of cases they do not lead to an accident. Only an accumulation of mistakes necessarily results in an accident.

Many scenarios describe the development of accidents. Technical defects are of secondary importance; ultimately, human errors turn the balance. An accumulation of ten errors may seem unlikely, but this actually caused a collision between a Dutch and a Belgian ship in the South-China Sea.

Fortunately one can learn from accidents, although people tend to search for "culprits" instead of the causal factors. It is a pity that the collision in the South-China Sea did not receive the attention it deserved. The number of mistakes was exceptional and the circumstances extremely improbable. In all, a composition of ten errors were made - the absence of one of which would not have resulted in a collision. Unfortunately each mistake was made at a critical moment, resulting in the collision of two ships on a wide ocean and with a closing speed of almost 31 knots.

Factual information.

It is nearly midnight. Visibility is good with the Dutch freighter "Rijnvaart" bound from Hong Kong to Singapore. On an opposite course the Belgian tanker "Belgica" approaches. Both ships are more than a hundred miles apart, but are proceeding on collision-course.

Each ship is equipped with a well-functioning radar. The radar scope of the "Rijnvaart", however, is situated in a radar cabin from which outside vision is obscured, thus the man operating the radar cannot maintain an adequate lookout. Moreover the first officer of the "Rijnvaart", Bakema, received his radar training sixteen years ago; since then no refresher course has been attended, neither has any relevant technical literature been studied.

At 23.50 the captain of the "Rijnvaart" is relieved by the first officer and writes his instructions in the log-book, thereby committing the

1st error.

One of the instructions was unclear; it obliged the first officer to warn the captain in particular circumstances, without specifying what had to be considered as particular.

At 05.10 the captain appears on the bridge again because land is within sight. Five minutes later there is little he can do and he returns to his cabin. During that short period Bakema has reported that someone had called on channel 16. As it transpired, the first officer then committed the

2nd error

by ignoring the call and by not investigating which ship is in his vicinity. A few moments later the cadet-officer of the "Belgica" makes a comparable

3rd error.

On the radar screen he sees a weak echo at a distance of 12 miles. After five minutes this echo has disappeared. No further thoughts are spent and the radio is not used to find out who was sailing there.

In the meantime, at 05.35, Bakema discovers on the radar a tropical rain-shower at 8 miles distance. Calculation indicates that the rain-shower will pass by at one mile distance. Now Bakema commits a fatal

4th error,

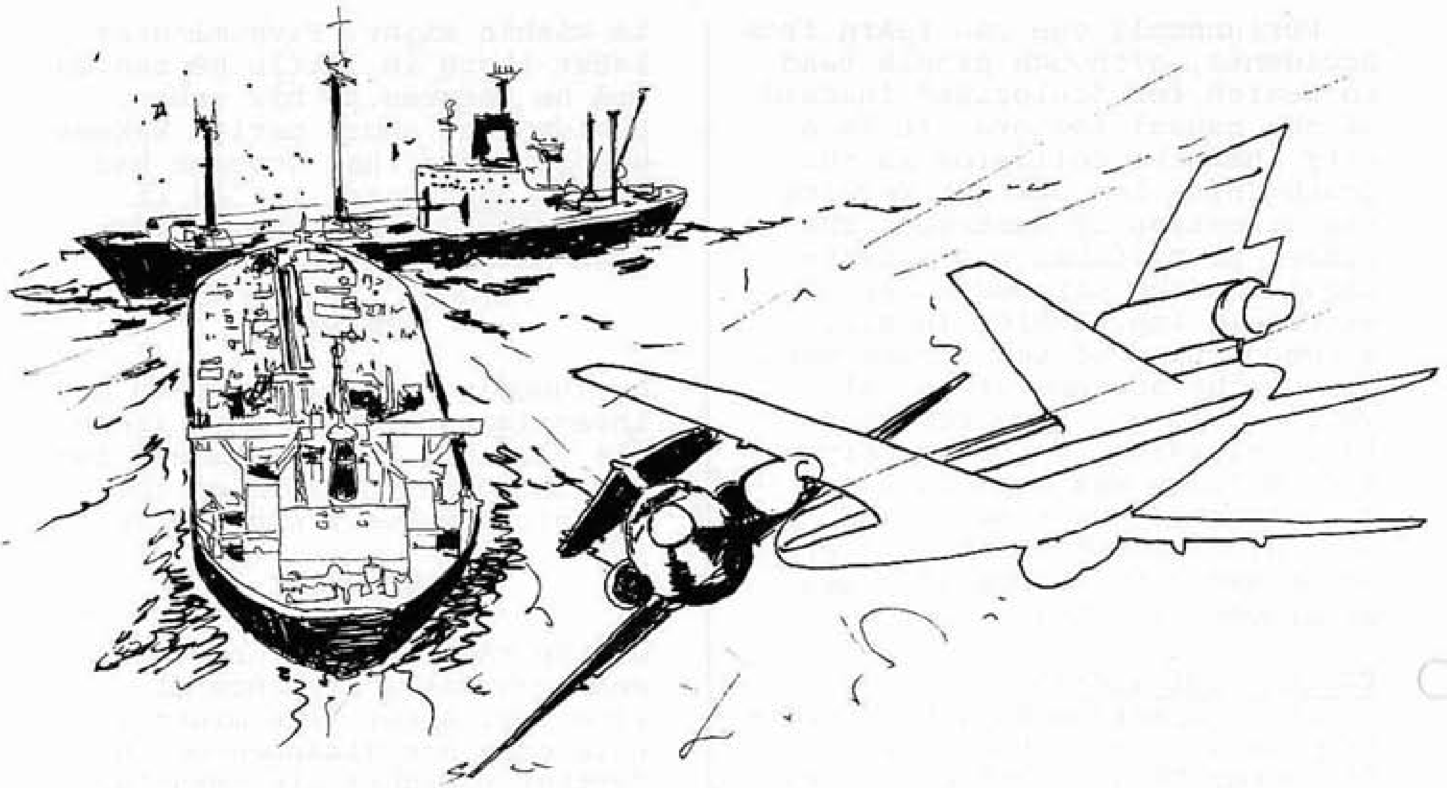
as he decides not to alter course because of the rain-shower. In doing so he forgets that the shower may hide other ships, at least he over-estimates the possibilities to locate such ships by radar.

Due to his unfamiliarity with the operating instructions of the radar equipment he makes a

5th error.

He adjusts the radar to large scale, thus reducing the possibility to detect ships behind the rain-shower. Indeed, the correct procedures were mentioned in the directions for use, but the first officer never took pains to read them.

At 05.58 it is evident that the shower does not pass by: the



"Rijnvaart" has to go right through. Visibility reduces quickly and Bakema begins to worry. Bad communications actuated the

6th error.

Six o'clock is tea time on board and Ho Ming, the look-out requests permission to leave the bridge. Communication with the Chinese crew-members is normally effected in broken English and Bakema, pointing at the rain, says: "Rain, no can do". The sailor, observing the sign-language from outside the wheel-house, misunderstood and disappears to the mess-room. Bakema is not pleased at all and commits the

7th error.

The sailor is not instructed to return and no provision is made for replacement. After realising that he is alone on the bridge, Bakema decided to monitor the radar. The ship continues its course through heavy rain and thunderstorms on the auto-pilot, without effective look-out on the bridge, while the only crew member available monitors a radar set to an inappropriate range. This situation would not have occured but for the first officer's

8th error;

he omits to call the captain. By using the radar he endeavours once more whether the circumstances necessitate such a course of action. The fact that he is concerned about small fishing-boats, which certainly cannot be seen on the radar, does not prevent him from making the

9th error.

Despite poor visibility he gives no sound-signal, clearly of the opinion that fishing-boats have to keep a sharp look-out themselves.

Finally, the greatest act of carelessness is the

10th error.

The "Rijnvaart" continues to sail at full speed, 18 knots. Behind the shower the "Belgica" approaches at 13 knots. With the visibility of only 900 metres and only one minute's sailing time apart it is clear that a hazardous situation exists.

Indeed, one minute prior to the collision the officer of the "Belgica" observes a ship emerging from the rain-shower. He immediately reacts with hard starboard rudder, but naturally a tanker with a length of 250 metres will not turn at once. On the "Rijnvaart" nobody keeps a look-out and although the ship was fairly manoeuvrable, it does not turn for collision avoidance.

The ships collide at 06.04, bringing about extensive damage. Much energy is released and two tanks of the "Belgica" burst open, but because she sails in ballast the "Belgica" doesn't catch fire. Severe injuries do not occur and notwithstanding heavy damages both ships can continue their journey.

Analysis.
Each error was an essential condition, the absence of one of them would not have resulted in a collision. A minimum of additional precautions would have been sufficient to avert a disaster. Which provisions would have been possible?

Misunderstandings resulting from ambiguous communications gave cause to error 1 and 6. A parallel with the air-crash at Tenerife in 1977 will stress the importance of correct and concise communications. The inability to anticipate underlie error 2 and 3. As long as the visibility was excellent both crews didn't care much for radio or radar; they didn't realise the importance of present information in periods with poor visibility.

Over-estimation of the contribution of radar to increased safety have led to error 4, 7, 8 and 10. Radar is a supplementary means to search for ships in the neighbourhood and does not replace vision. Also radar has its limitations; the operator has to check its functioning regularly, e.g. by keeping a look-out or by continuous radio-communication with other ships.

Error 5 arose because the personnel didn't receive additional schooling at regular intervals. It is common procedure in aviation that crews practise in flight-simulators extremely important manoeuvres which occur relatively infrequently. Such simulators also exist for shipping, but they are used too little for this purpose.

How little account was taken of accidents is emphasized by error 9. The first officer was aware of the possible presence of fishermen too small to be detected by radar and in addition he knew that they did not carry radar themselves. Nevertheless he didn't consider even once to give the prescribed sound-signals.

Cause and Consequence.
To prevent accidents we have to eliminate the causes. It has been mentioned already that most accidents are brought about by human error. However, it is clear that none of the ten human errors was an obvious blunder, but it is also impossible to point to culprits. All mistakes have been made many times before by the same people, but have never resulted in a collision. When a fault, which is serious in itself, never causes an accident, it creates the impression that such an error is not serious at all and that the procedures laid down are not in proportion - the relationship between cause and consequence fades away.

It is difficult to pin-point "the" cause leading to an occurrence. People have a distinct notion of "cause" and therefore one should differentiate between "necessary conditions" (B can only occur after A) and "sufficient conditions" (B is the inevitable consequence of A). The mistakes in our example all play a necessary part but neither of them is sufficient, while the scenario itself is sufficient but not necessary. This is a fundamental problem in the prevention of accidents. Even if one of the errors would have been absent, we can still imagine many other circumstances leading to an accident.

To prevent accidents one should list all probable scenarios, i.e. all circumstances which are not necessary but sufficient to cause an accident. With such a risk-analysis it is possible to determine the necessary insufficient conditions of probable scenarios.

Accidents do not originate as a direct consequence of one minor inadvertent fault, but usually from an accumulation of such human errors. Yet, that happens so seldom that nobody learns many lessons from personal experience. Only information about accidents in the past can indicate what kind of errors lead to fatal occurrences. In order to prevent that such mistakes are made we have to change human behaviour.

A side-step to the air-crash at Tenerife is due here. The following fatal communication has taken place:

- 17.05.41. PHBUF: "KLM 4805 is now ready for take-off and we are waiting for our ATC-clearance".
- 17.05.53. Air traffic control: "KLM 8705, you are cleared to the PAPA-beacon; climb to and maintain FL90, right turn after take-off, proceed with heading 040 until intercepting the 325 radial from Las Palmas VOR".
- 17.06.09. PHBUF: "Roger sir, we are cleared to the PAPA-beacon, FL90, right turn out 040 until intercepting the 325 and we are now at take-off" (or "we are now, eh, taking-off." - this was not exactly understood).
- 17.06.18. Air traffic control: "Okay".
- 17.06.20. Air traffic control: "Stand-by for take-off, I will call you".
- 17.06.20. N736PA: "We are still taxiing down the runway, the PA1736".

The KLM-crew, reading back the ATC-clearance, reports ready for take-off at the same time. The reply of the air traffic controller, "Okay", is the death-sentence of 574 people, as it is understood as a take-off clearance. The air traffic controller probably meant to say that the ATC-clearance was correctly understood; he hesitates two seconds and then instructs to stand-by for take-off. This call never reaches the KLM-crew because of a simultaneous transmission of the anxious crew of PA1736.

The normal usage of language is too subtle to preclude fatal misunderstandings. It is recommended to formalize communication procedures to a greater extent and to discontinue the use of incorrect and non-standard phraseology. The application of strict procedures, however, is often conceived as stickling for regulations and discipline, childish and humiliating. Better knowledge of accident-casuistry could take away these ideas from the parties concerned. It might be useful to provide material on accidents for training purposes. Human behaviour can only be changed when the actors realize that an accident usually is not an "act of God".

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After lengthy deliberations about the feasibility of 2- or 3 crew cockpit configuration for the A 310 - Airbus we now offer the following solution:

THE SINGLE CREW CONFIGURATION

The FAA Air Traffic Control Systems "Command Centre" at Washington

by Patrice Behier

Having recently experienced the hospitality of the young and highly motivated personnel of "People Express" on a flight from Newark to Washington, Mr. de Bruyn and I considered it would be of interest to visit the FAA "Command Centre" in the FAA building.

In the United States 22 area control centres share more than 30 million flight movements a year and more than 70 million take-offs and landings are controlled by the tower controllers. These figures clearly indicate the magnitude of the difficulties which may arise in the arrangements for an orderly and efficient flow of aircraft. Fortunately the United States have a single civil aviation authority, which created the "Command Centre", the sole organisation responsible for the regulation of the air traffic flow over the whole country.

To that effect the following equipment, among others, is utilized in the "Operations Room".

1. A switchboard with direct telephone lines to the 22 area control centres and the principal control towers, capable of connecting them in conference.
2. Three giant screens along the wall.
   - On the first one meteo charts can be projected.
   - On the second one pictures can be selected showing airport structures, including runways, buildings, towers, etc., to enable the understanding of any particular situation that might occur (e.g. accident, incident).
   - On the third one the following information can be visualized: weather conditions for each airport or area, flow control lists, airline lists or anything else of interest.
3. Above the screens seven clocks indicate the various zone-times.
4. Part of the Operations Room area is used by professional meteorologists. They have a direct link to the various civil and military meteorological stations and have a separate computer at their disposal. Satellite pictures enable them to assess weather developments throughout the territory.

It goes without saying that the "Command Centre" owns a powerful computer in Jacksonville which easily digests the tremendous amounts of figures and parameters concerning the United States' air traffic. The following objectives are pursued.

- Suppression of in flight delays and holdings.
- Traffic management in advance by assigning take-off slot times taking into account the general situation, i.e. airspace saturation, airport congestion, traffic peaks, etc. Participating airlines produce their flight schedules as far as possible in advance. In addition the supervisor in charge negotiates every morning with airline managers on how alternative flight planning might solve expected problems.
- Traffic management in respect to exceptional circum-

stances, such as failures, thunderstorms, cloud fronts, traffic overload, airport congestion, cyclones, strikes, etc.

Derived from their experience three special procedures are in use.

Fuel Advisary Departure (FAD)

Applied when the forecasted expected approach time represents a delay of 60 minutes or more.

Quota Flow Control Procedure (Q. Flow)

Applied whenever saturation of an airport, a group of airports or any area over the territory results in a delay of 60 minutes or more.

Severe Weather Allocation Plan (S.W.A.P.)

Self explanatory.

Teams of five controllers and a supervisor ensure a 24 hour service. All of them have an experience in air traffic control of over 20 years and have performed supervisory functions in ACCs or main control towers. The people in charge contribute considerably to the efficiency and economy of air transport. The United States' airlines do not complain, on the contrary, day after day they realise how useful the system is and how much money can be saved by reducing the amount of fuel burnt.

Would the various European administrations and airlines appreciate the need for an equivalent to the "Command Centre"? A similar organisation is perhaps already at hand, the Eurocontrol Central Data Bank.

Artificial Stars

Errors in navigation can be costly, even fatal. They should soon be unnecessary as well. By 1988, civilian ships and aircraft (and maybe canny hikers too) will be able to tune into space-based beacons, a system of American satellites, and triangulate their position to within 100 metres. Privileged military users will be able to fix their location to within just 15 metres.

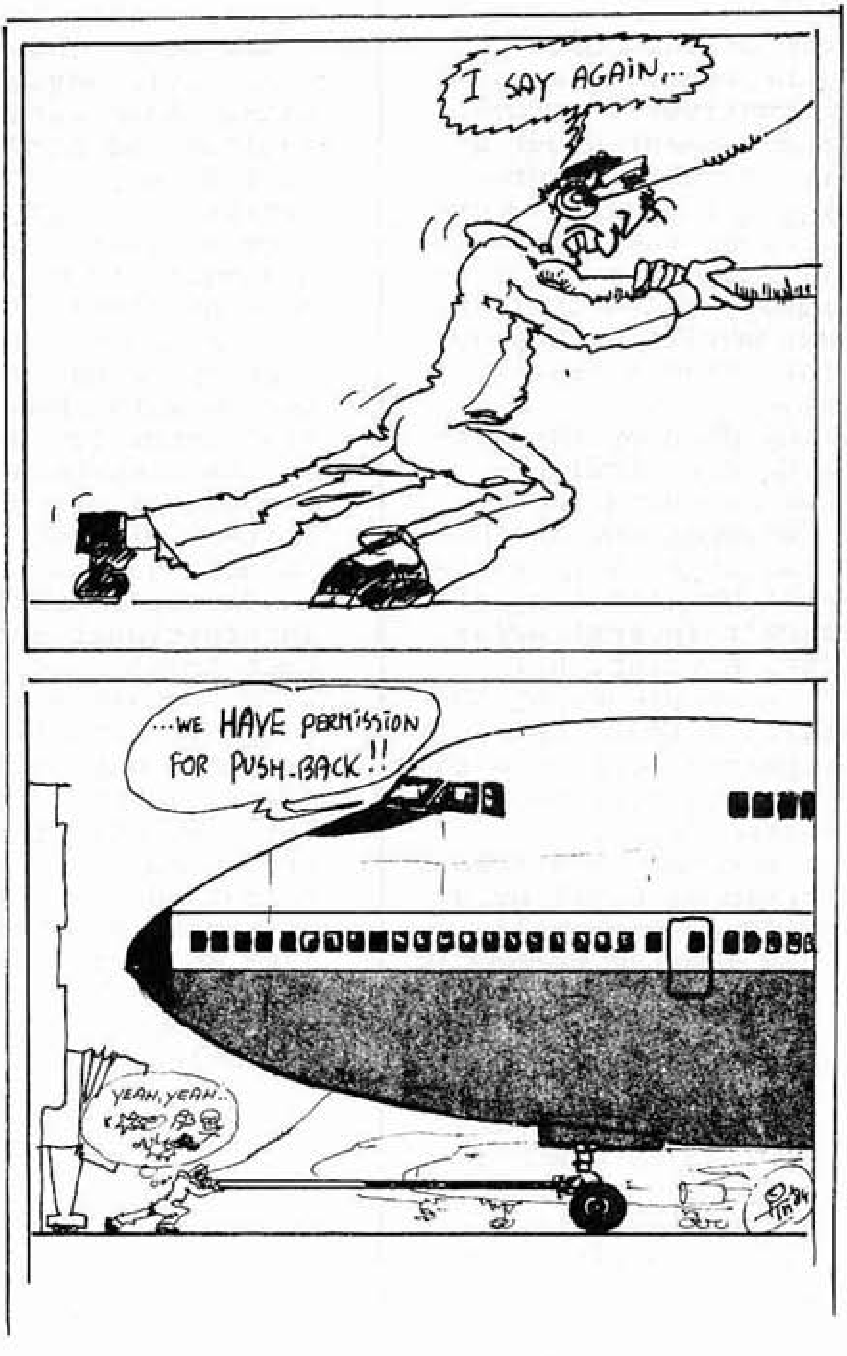
At present, an aircraft well out over, say, the Atlantic (or astray over Siberia) does not know precisely where it is. It only knows, from a computerised gyroscope system, how far it has gone in which directions from its starting point. And the dead reckoning from such inertial systems can be as much as 16 kilometres out by the end of a transatlantic flight. Corrections must normally wait on signals from ground-based radio beacons or radar sighting of land features.

The satellites in the American system are intended to act purely as passive beacons; they will not be communications satellites. In fact, there is another such passive satellite-navigation system already in existence. Called Transit, it is owned by the American navy. But it is old and boasts only five satellites - far too few to ensure that any one, let alone three, space-beacons are in sight at any one time. At best, it is accurate to within 500 metres. That is good enough to attract many civilian yacht owners (receiving equipment can be had for as little as $1,500) but not many others.

To replace it, the American defence department has placed a $1.7 billion contract with Rockwell International, the manufacturers of the space shuttle, for a new system called the Navstar Global Positioning System. When fully operational in 1988, Navstar will comprise 18 satellites (plus 10 spares) in six 12-hour orbits. Given the appropriate code would-be users of the system will be able to determine their position to within 15 metres by tuning into the signals from any three satellites.

That kind of accuracy will be of immence benefit to terrain-hugging missiles like America's Cruise, to mobile launch platforms like submarines and to military vehicles on night-time manoeuvres. The trouble is that a beacon is there for all to see and the Pentagon has no intention of laying on Navstar's services for the Russians (as it is, the Russians are developing their own system, Glonass). So Navstar's signals will be encoded. The most accurate information will be restricted to a secret code available to the American military. Other users, whether western civilians or Russians, will be able to figure out where they are only to within 100 metres - an accuracy adequate for most civilian navigational purposes.

There has been a row in Washington over whether civilians should pay. Congress initially



took the view that users should be charged $300 a year in order to recoup some of the costs of the system (the Pentagon considered an alternative of a royalty on user equipment under a licensing arrangement). Those against charges, including Rockwell itself, argue that a fee would put off customers, be difficult and expensive to collect, and of dubious morality (nobody is charged for using a beam from a lighthouse).

The shooting down by the Russians of the Korean airliner last September may have tipped the scales. Congress now has before it two resolutions to allow civilian use of Navstar free of charge. America's Federal Aviation Authority, however, has reservations about promoting the use of Navstar. It fears that civilian navigators will come to rely on it - and be left high and dry if the system fails.

Its fears may not be shared by the International Civil Aviation Organisation, which will have to endorse Navstar before it can be used worldwide. It is expected to give its approval by 1987, if only because Navstar will be far cheaper to maintain than present systems. Receiving equipment will also be cheap, costing about $10,000 per set, roughly a tenth of the cost of an inertial navigational system.

Potentially, the market for Navstar could be wider. Industries other than those concerned with civil navigation are interested. Both offshore oil installations and communications satellites rely on highly accurate position fixing and could benefit from Navstar - but only if the high-quality military codes were made available to them.

Across the Atlantic, the European Space Agency, Esa, has been toying with the idea of a commercial satellite navigation system of its own. Navsat would aim to compete by using 24 cheaper satellites (without anti-jamming equipment), giving accuracy as good as Navstar's military code, under international civilian control. Last April, Esa signed a contract with Britain's Racal to design suitable satellites. But a decision whether to go ahead with Navsat is not expected before 1986. By that time, especially if the American congress does relent on its original charging scheme, Navstar may already have won the race.

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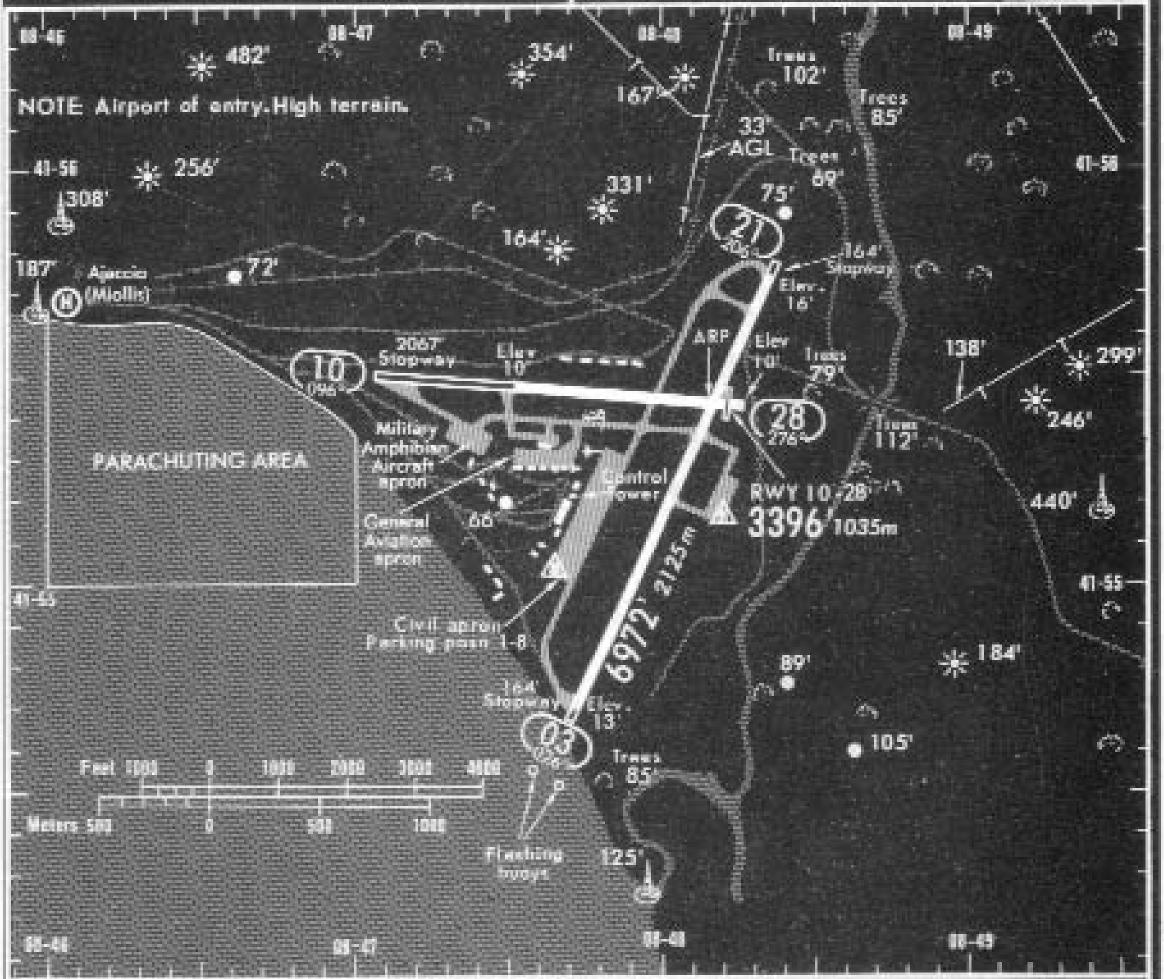
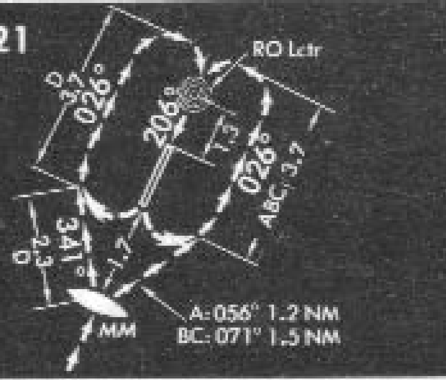


ADDITIONAL RUNWAY INFORMATION

RWY		USEABLE LENGTHS LANDING BEYOND Threshold	Glide Slope	TAKE-OFF	WIDTH
03	HIRL		5791' 1765m	②	164' 50m
21	RL REIL VASI (3.70°)	①			
10 ③					98' 30m
28		3182' 970m			

① Landing not authorized except during DAY in VMC.
② Take-off not authorized except during DAY in VMC.
③ Right hand circuit rwy 10.

Rwy **21**



CIRCLE-TO-LAND
with prescribed
flight tracks
NIGHT NA

	MDA	CEIL-VIS
A	900' (884') ▮	180m- 2000m
B *C	1600' (1584')	320m- 2800m
D	1600' (1584')	320m- 3200m

*ACFT with speed (1.3 Vso) above 135 KT use D minimums.

Without air transport authorization see approach E-21.

▮ After VOR Lctr or Lctr apch: 1340' (1324') 270m- 2000m.

TAKE-OFF

	AIR CARRIER (FAR 121 & 123) If Wx below Lndg Mim, t/o Altn Req.	OTHER AIR CARRIER		Rwy 21 only
2 Eng	400 m	A		200m
3 & 4 Eng		B		300m
		C		
		D		400 m

FOR FILING AS ALTERNATE

	Precision	Non-Precision
A B C D	195m- 3200 m	405m- 3200 m

CHANGES: Rwy 10-28 length & width.