National Air Traffic Services

AIR TRAFFIC CONTROL AT CARDIFF-WALES AIRPORT

NATS

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Introduction by the Chief Officer, Civil Aviation Authority, Cardiff-Wales Airport

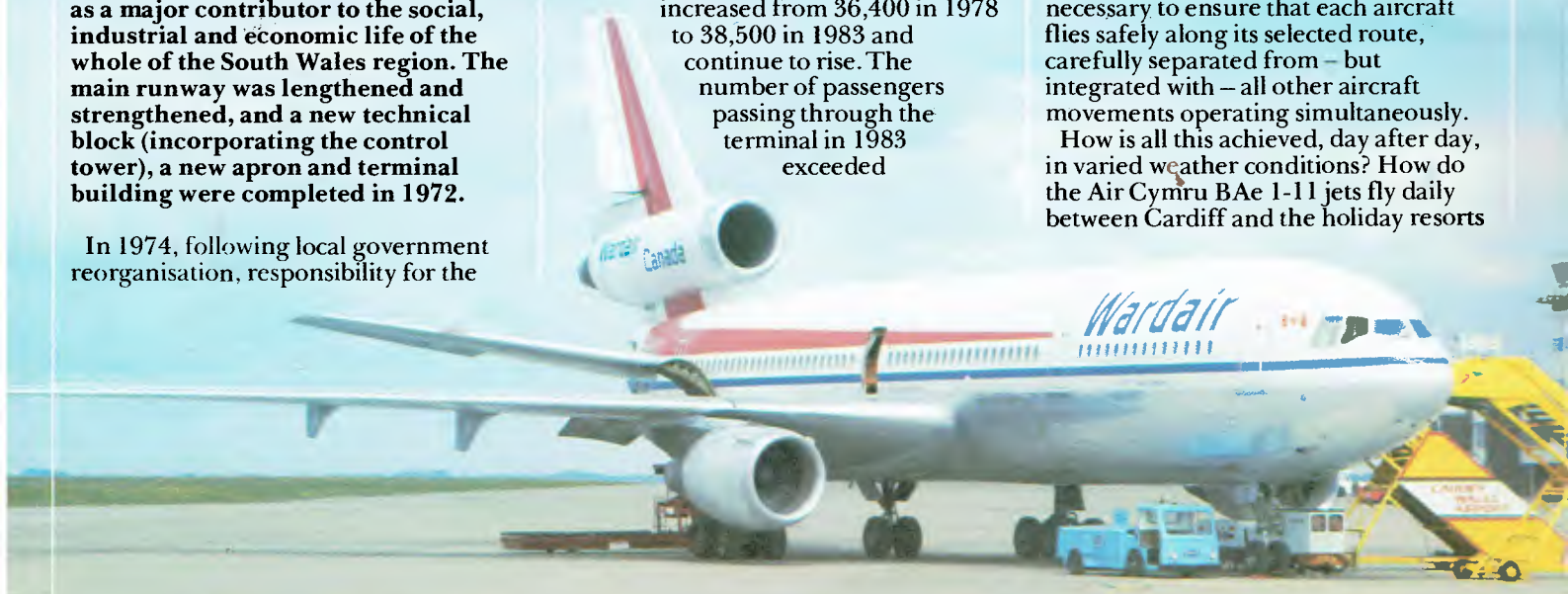
Cyflwyniad gan Brif Swyddog Awdurdod Hedfanaeth Sifil, Maes Awyr Caerdydd-Cymru

Cardiff-Wales Airport has been used by civil aircraft since 1952, but its origins lie in its first role as a training base for Spitfires in 1942. When control of the airport, then known as Glamorgan (Rhoose), was transferred from the Ministry of Aviation to Glamorgan County Council in 1965, it was decided to develop the facility so as to confirm it as a major contributor to the social, industrial and economic life of the whole of the South Wales region. The main runway was lengthened and strengthened, and a new technical block (incorporating the control tower), a new apron and terminal building were completed in 1972.

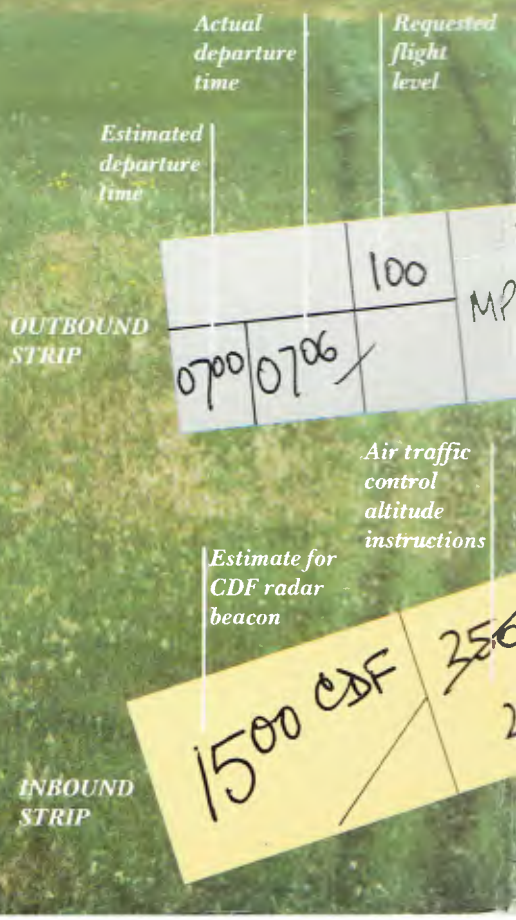
In 1974, following local government reorganisation, responsibility for the airport was transferred to a consortium of three county councils – West, Mid and South Glamorgan – who subsequently adopted its present name, Cardiff-Wales Airport. Since 1978 it has been designated a Category B regional airport, serving Wales and the South-West. It has a catchment area of between two and three million people. The annual aircraft movements have increased from 36,400 in 1978 to 38,500 in 1983 and continue to rise. The number of passengers passing through the terminal in 1983 exceeded 385,000. A new runway extension scheduled for completion in 1985 opens up the possibility of direct trans-atlantic flights.

To most air travellers the radar aerial rotating smoothly on top of the control tower at Cardiff-Wales Airport is a visible reminder of the air traffic services, but few will be aware of the nationwide organisation and planning necessary to ensure that each aircraft flies safely along its selected route, carefully separated from – but integrated with – all other aircraft movements operating simultaneously.

How is all this achieved, day after day, in varied weather conditions? How do the Air Cymru BAe 1-11 jets fly daily between Cardiff and the holiday resorts



The pilot of every public transport aircraft (that is, one that carries paying passengers or freight or both) must file a flight plan. The pilot plans his route, decides his economical height and speed, and calculates his fuel requirement. His flight plan also gives the time he expects to arrive at various points, and his ETA (estimated time of arrival at his destination). Before completing the flight plan, the pilot consults the meteorological department because wind strength affects his speed, and he may need to alter height or course to avoid bad weather, or to take advantage of a following wind. Finally, he submits his flight plan to Air Traffic Control. The flight plan is presented to the controller as a flight progress strip.



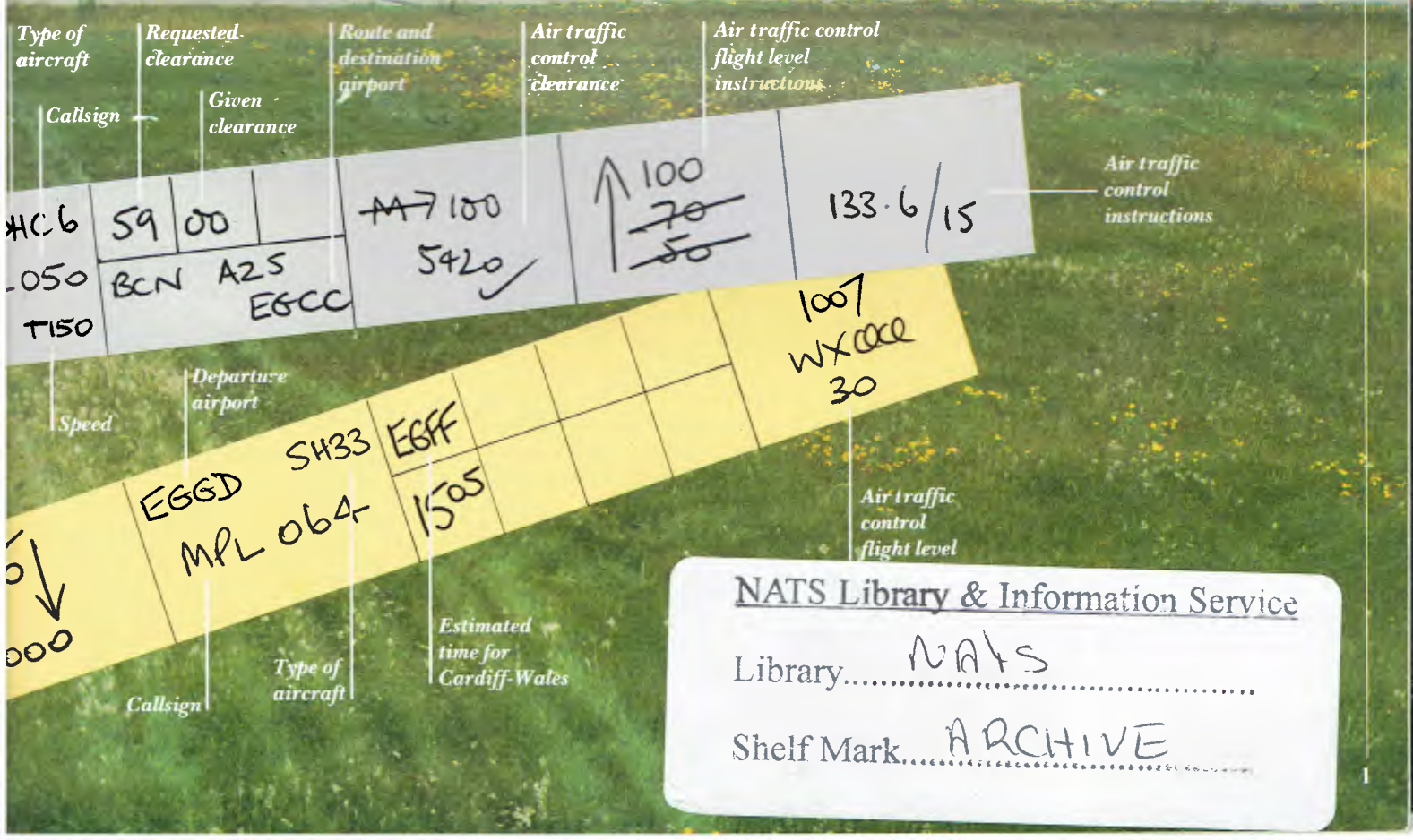
of Spain safely and efficiently, and how are the many and varied aircraft operations integrated? In an endeavour to explain these and other questions, this booklet aims to take the reader into the realms of the National Air Traffic Services (with special reference to Cardiff-Wales) and to describe the highly sophisticated and very expensive technology needed to ensure that air traffic flows non-stop throughout each day of the year, safely and efficiently.

Mae Maes Awyr Caerdydd-Cymru wedi cael ei ddefnyddio gan awyrennau sifil ers 1952 ond fe'i sefydlwyd gyntaf fel safle hyfforddi ar gyfer awyrennau 'Spitfire' yn 1942. Pan drosglwyddwyd rheolaeth y Maes Awyr, a adnabyddid y pryd hynny fel Morgannwg (Rhws), o'r Weinyddiaeth Hedfanaeth i Gyngor Sir Morgannwg yn 1965, penderfynodd yr awdurdod newydd ei ddatblygu a'i wneud yn brif gyfrannwr i fywyd economaidd, diwydiannol a chymdeithasol De Cymru i gyd. Cryfhawyd ac ymestynnwyd y brif redfa a chwblhawyd adeilad technegol – sy'n cynnwys y Tŵr Rheoli – iard awyrennau newydd, ac adeilad ymadael, yn 1972.

Yn 1974, yn dilyn ad-drefnu llywodraeth leol, trosglwyddwyd y cyfrifoldeb am y maes awyr i gwmni'n cynrychioli tri Chyngor Sir – Gorllewin, Canol a De Morgannwg – a fabwysiadodd wedyn ei enw presennol Maes Awyr Caerdydd-Cymru. Ers 1978 mae wedi'i ddynodi yn Faes Awyr Rhanbarthol Categori B sy'n gwasanaethu Cymru a'r De Orllewin, dalgylch o rwng 2 a 3 miliwn o bobl. Mae teithiau blynyddol awyrennau wedi cynyddu o 36,400 yn 1978 i bron 38,500 yn 1983, ac yn parhau i gynyddu. Roedd y nifer o deithwyr a ddefnyddiodd yr adeilad yn 1983 yn fwy na 385,000. Mae estyniad newydd i'r rhedfa i'w gwblhau yn 1985 yn dod â'r posibilrwydd o hediadau uniongyrchol ar draws yr Iwerydd.

I'r rhan fwyaf o deithwyr awyr mae'r erial radar sy'n cylchdroi'n llyfn ar ben Tŵr Rheoli Maes Awyr Caerdydd-Cymru yn arwydd gweladwy o wasanaethau'r Rheolaeth Trafnidiaeth ond ychydig fydd yn ymwybodol o'r trefniant cenedlaethol a'r cynllunio angenrheidiol i sicrhau fod pob awyren yn hedfan yn ddiogel ar hyd ei thaith ddetholedig, wedi'i chadw ar wahân yn ofalus, ond yn gyfunol â holl symudiadau awyrennau eraill sy'n gweithredu'n gyfamserol.

Sut y cyflawnir hyn dydd ar ôl dydd mewn cyflyrau tywydd amrywiol? Sut er enghraifft y mae awyrennau B.Ae 1-11 Awyr Cymru yn hedfan yn ddyddiol rhwng Caerdydd a chyrchfannau gwyliau Sbaen yn ddiogel ac effeithiol a sut y cyfunir gweithrediadau yr amryfal awyrennau. Mewn ymgais i egluro'r rhain a chwestiynau eraill, ceisia'r llyfryn hwn fynd â'r darllenydd i fyd Gwasanaethau'r Trafnidiaeth Awyr Cenedlaethol (gan gyfeirio'n arbennig at Gaerdydd-Cymru) ac i ddisgrifio'r dechnoleg tra soffistigedig a drudfawr sydd ei hangen i sicrhau fod trafnidiaeth awyr yn symud yn ddiogel ac effeithiol ddi-rwystr trwy gydol pob dydd o'r flwyddyn.



UK AIRSPACE

United Kingdom airspace extends not only over the land mass, but also over the surrounding seas and oceans, where it meets the airspace of adjacent countries. UK airspace is divided into two Flight Information Regions (FIRs): London and Scottish. Aircraft flying in these two Regions are controlled from three centres. Those in the London FIR are controlled from the London Air Traffic Control Centre at West Drayton, Middlesex and from the Manchester Sub-centre situated at Manchester International Airport.

The Scottish FIR is controlled from the Scottish Air Traffic Control Centre at Prestwick, several miles south-west of Glasgow. Within these FIRs are areas of controlled airspace, which are themselves divided into three parts.

1. Control Zones surround and protect major airports. The control zone for Cardiff-Wales extends to 5500ft.

2. Terminals Control Areas (TMAs) protect the intersections of busy airways and groups of large airports.

3. The airways, which could be described as motorways in the sky, connect the TMAs. The airways are corridors of space ten miles wide up to a height of 24,500 ft from a base which is usually between 5000 and 7000 ft. Above the airways, Upper Air Routes cater for high flying aircraft, many of which are over-flying UK airspace.

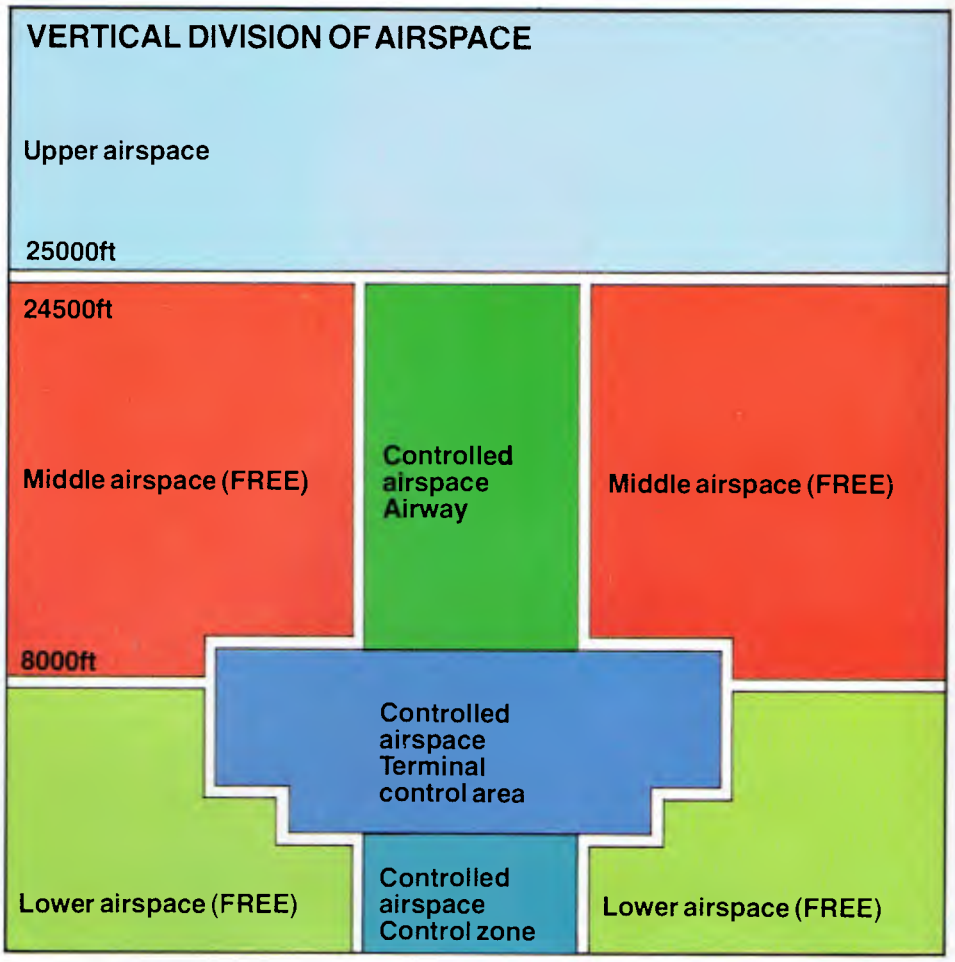
4. Additional regulated airspace known as **Special Rules Zones** and **Special Rules Areas** provide protection around certain major airports. Cardiff-Wales is protected by Special Rules airspace and a Control Zone.

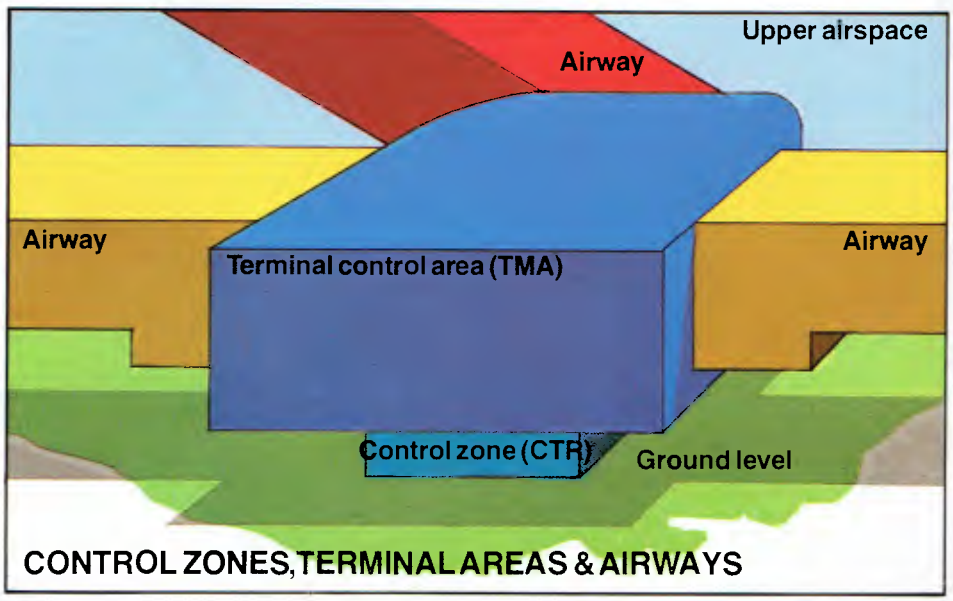
NATIONAL AIR TRAFFIC SERVICES

Air traffic control over the United Kingdom and at most of the major airports is provided by the National Air Traffic Services (NATS), an organisation responsible jointly to the Civil Aviation Authority (CAA) and the Ministry of Defence (MoD) for the guidance of both civil and military air traffic.

The prime objective of NATS is to ensure the safe, orderly and expeditious flow of air traffic, but the system is also designed to minimise operational delays, fuel consumption and aircraft noise.

NATS has provided air traffic control and its associated technical services at Cardiff-Wales since 1952.





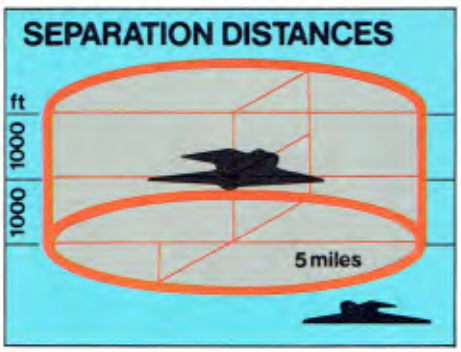
Approach radar controllers ▶

AIRWAYS IN UK AIRSPACE

SERVICES PROVIDED BY NATS

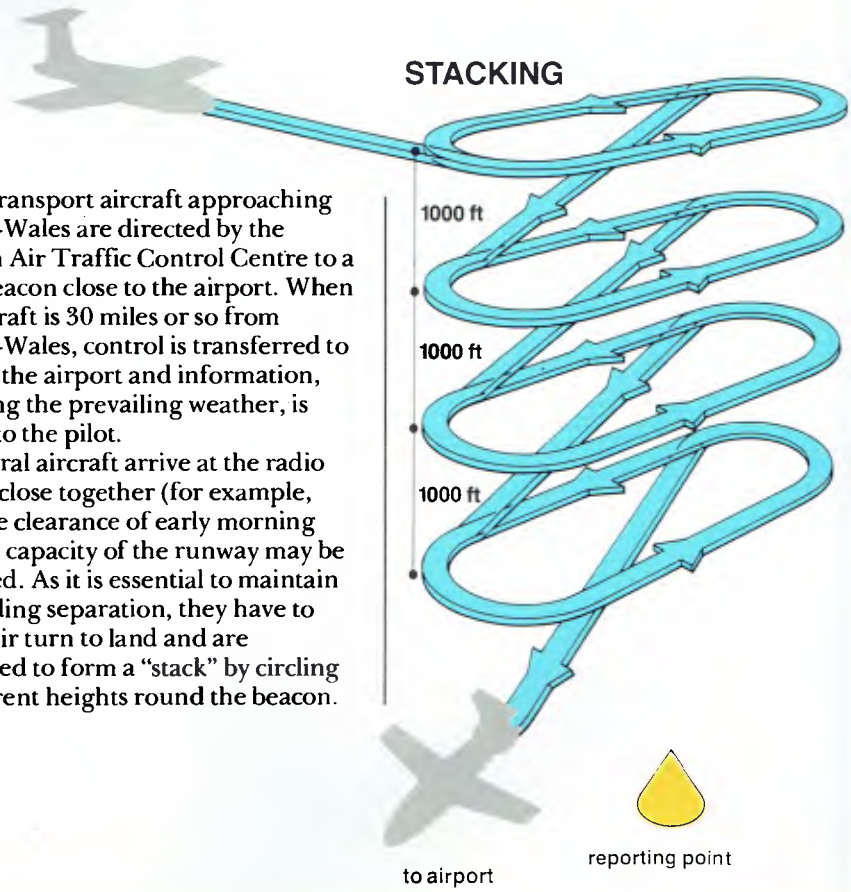
As well as ensuring that aircraft are adequately separated, the National Air Traffic Services provide flight information and alerting services to aircraft flying under their control. Flight information consists of all the data required for the safe navigation of aircraft, such as the radio frequencies of airport control towers, the serviceability of navigation aids, the height, speed and direction of other aircraft in the vicinity when required, and the weather conditions en route and at the destination airport. Should an emergency arise, the Alerting Service brings into action all those organisations that can assist, such as the rescue co-ordination centres, the police and other rescue services including fire brigades and HM Coastguard.

In controlled airspace, the function of air traffic control is to keep each aircraft safely separated from all others in accordance with internationally agreed standards. This is achieved either by



allocating different heights or by arranging certain minimum horizontal distances between aircraft. The separation distances vary: for example, an aircraft flying along the airways under radar surveillance may not pass within 5 nautical miles of another if it is at the same height; on the other hand, if two aircraft are less than 5 nautical miles apart horizontally, then they must be at least 1000 ft apart vertically. Above 29,000 ft, this separation is increased to 2000 ft.

CONTROLLING INCOMING AIRCRAFT



Public transport aircraft approaching Cardiff-Wales are directed by the London Air Traffic Control Centre to a radio beacon close to the airport. When the aircraft is 30 miles or so from Cardiff-Wales, control is transferred to ATC at the airport and information, including the prevailing weather, is passed to the pilot.

If several aircraft arrive at the radio beacon close together (for example, after the clearance of early morning fog) the capacity of the runway may be exceeded. As it is essential to maintain the landing separation, they have to wait their turn to land and are instructed to form a "stack" by circling at different heights round the beacon.

IN THE CONTROL TOWER AT CARDIFF-WALES

In the control tower at Cardiff-Wales there are two distinct air traffic control functions – Approach Control and Aerodrome Control. Although these two functions are situated on different floors in the tower, the procedures which are used give a fully integrated service. Approach Control is responsible for aircraft arriving at Cardiff-Wales. It controls them from the moment London Air Traffic Control Centre hands them over until they have been lined up to land on one of the runways, when Aerodrome Control takes over.

Approach Control also provides a service to military aircraft flying into RAF St Athan, 3½ miles to the west of Cardiff-Wales. Since NATS is a joint Civil Aviation Authority/Ministry of Defence organisation, the respective staffs at Cardiff-Wales and RAF St Athan are able to work together in a co-ordinated and harmonious environment. Only through the medium of a unified approach control service is it possible to achieve the necessary flexibility and efficiency.

Aerodrome Control operates from the Visual Control Room at the top of the control tower, some 70 ft from the ground with a panoramic view of the airport. From here, aircraft are controlled on their final approach to land, when they are preparing for departure, taxying and during actual take-off. Aircraft and vehicles moving on the runways and taxiways are also controlled from the Visual Control Room.

Aerodrome controllers in the Visual Control Room

APPROACH CONTROL

Approach Control is manned by two radar controllers, who are designated No. 1 and No. 2. The Cardiff No. 1 radar controller is responsible for all traffic within the Cardiff Control Zone. He is also responsible for traffic in the Cardiff Special Rules Zone and Special Rules Area which together form part of airspace stretching across most of the Bristol Channel, and within which all aircraft must contact Cardiff Radar. The No. 2 radar controller assists the No. 1 controller, especially in the final approach phase, but in general the tasks are shared so that neither controller becomes overloaded.

The radar controllers continuously instruct pilots of arriving aircraft to adjust their height, speed and route to ensure an orderly stream of aircraft, separated from the departing aircraft. Before final approach, the controller establishes the correct landing intervals and ensures that all aircraft are correctly separated according to the prevailing weather conditions and types of aircraft involved. Because of their great size and weight, wide-bodied aircraft such as the DC-10 create more turbulence to the air through which they pass than smaller or slower aircraft. As this turbulence can upset the flying characteristics of lighter aircraft following behind, greater separation distances have to be provided.

Many aircraft, particularly smaller ones such as those engaged in business or air taxi operations, fly at lower altitudes than the big jets. For such flights operating within a 30-mile radius of Cardiff-Wales Airport, a Radar Advisory Service is provided by Air Traffic Control. Radar guidance and advice is given to assist pilots who are flying in this area and to others who are approaching to land at or have taken off from the airport.

Aircraft approaching Bristol Airport from the west are also controlled by Cardiff-Wales because of the close proximity of the traffic patterns associated with the two airports.

The co-ordinated action of the two radar controllers ensures a safe passage for all aircraft whether it is a jet airliner bound for Alicante, a Cardiff-Wales-based helicopter, a fast military jet from St Athan or one of the many other varied types in daily flight over the Bristol Channel or the Brecon Beacons.

The No.2 Radar Controller ▶

▼ *Approach Control situated in the control tower*


205
RWY
30
213
No.2 DIRECTOR
KNOTS

AERODROME CONTROL

GROUND MOVEMENT CONTROL

When arriving aircraft are satisfactorily merged into one stream and aligned with the runway about 6–8 miles from touchdown, their control is transferred to the Aerodrome Controller in the Visual Control Room. It is his responsibility to make sure that the runway is safely used to its maximum capacity.

When, from his commanding position overlooking the whole of the airfield, the Aerodrome Controller can see that the runway itself is clear, he issues a landing clearance to the pilot of the first incoming aircraft. He gives the current direction and strength of the surface wind, the condition of the runway surface and, if for any reason it is not safe to land, he will issue 'missed approach' instructions.

The Aerodrome Controller

After an aircraft has landed it is important that it should leave the runway as quickly as possible to unload its passengers or freight. When the aircraft is clear of the runway, the Aerodrome Controller directs the aircraft to its parking stand, watches the taxying aircraft's progress and integrates its movements with other aircraft and vehicles. At Cardiff-Wales the Aerodrome Controller is responsible for the integrated movements of the airport service vehicles as well as for taxying aircraft, both inbound and outbound. All this traffic is in radio communication with the Aerodrome Controller.

In daytime when there is good visibility, he controls aircraft and vehicles by direct observation and this is

why the Visual Control Room occupies such a commanding position in the airport complex. During low visibility during the day, and at night, aircraft are guided by a combination of green centre-line and blue edge lighting with red stop bar lights embedded in the taxiways. The lighting is operated by the Aerodrome Controller using a panel in the form of an airport map, with switches that directly operate the lighting system on the airfield.

The Aerodrome Controller operating the airfield lighting panel

CONTROLLING DEPARTING AIRCRAFT

When an aircraft has loaded its fuel, catering supplies, baggage and passengers, the doors are closed and locked. The pilot illuminates the 'Fasten Seat Belts' sign and then makes a radio call to the Aerodrome Controller for permission to start engines. The controller advises the pilot when to start the aircraft engines so that he will not be unduly delayed in the air or on the ground, so saving fuel. He has to consider other aircraft starting up, whether there is any congestion along the outbound air routes – both in the UK and abroad – and the availability of time and height 'slots' made necessary by congestion.

When the Aerodrome Controller has given the pilot 'start up' clearance and received confirmation that he is ready to move, he allows the aircraft to taxi from its stand, advises the pilot which runway to use and guides him towards the runway holding point.

The Aerodrome Controller lines up the departing aircraft in sequence to obtain the maximum use of the runway. For example, when two aircraft of a similar type are departing, one for a northbound destination followed by one for a southbound one, they may be allowed to leave one minute apart but, due to the many different types of aircraft using Cardiff-Wales, the interval may be increased according to aircraft type and their specific departure route.

When the aircraft is lined up on the runway, the Aerodrome Controller issues take-off clearance. After becoming airborne, control is transferred to the Cardiff-Wales Radar Controller, who monitors the flight until control is transferred to the London Air Traffic Control Centre, or to another control agency which might be appropriate to the particular flight.

NOISE ABATEMENT

Aircraft noise is a nuisance for most people who live near an airport or under one of the flight paths. Wind, temperature and humidity changes can make a great deal of difference to the amount of noise heard at any particular time.

At Cardiff-Wales every effort is made to minimise this nuisance and local flying restrictions require all operators to make sure that their aircraft cause the least practicable disturbance around the airport. Local restrictions also apply to running aircraft engines on the ground.

All departing turbo-jet aircraft follow published routes and procedures to keep their noise to a minimum.

CONTROLLING TRAINING AIRCRAFT

NATS provides an air traffic control service to meet the various training requirements at Cardiff-Wales, where there is a resident flying school which trains pilots from initial to advanced standard.

NATS' experience and sophisticated equipment enable Air Traffic Control at Cardiff-Wales to handle military training aircraft, including such diverse types as Hercules freighters and Tornadoes.

Some of the smaller aircraft handled at Cardiff-Wales

TELECOMMUNICATIONS

Telecommunications are an essential feature in the safe and efficient operation of air traffic control. The equipment at Cardiff-Wales includes VHF air-to-ground communications, UHF air-to-ground communications cross-coupled to VHF for RAF St Athan military traffic, primary radar and closed circuit television systems.

RADIO COMMUNICATIONS

To ensure their efficiency, NATS at Cardiff-Wales have three VHF radio channels to control and direct aircraft in the air and on the ground, and one UHF radio channel to control military training from RAF St Athan.

In addition to the facilities for radio communication with aircraft, service vehicles at the airport are also provided with radio links. They use a UHF radio system which is linked to VHF aircraft channels so that controllers can hear both vehicles and aircraft as if they were on the same channel.

The whole radio network is fed through a distribution and control system which enables the controller to select any radio channel or telephone line he needs. He can use the telephone system without removing his headset because the left earpiece and the microphone are connected to the telephone, while the right earpiece remains connected to the radio network so that incoming radio calls can always be heard.

Standby and emergency services are incorporated in the system to maintain communications under all conditions.

The controller's headset – his communications link.

The VHF radio receiver aerials on the edge of the airfield

Each channel has a main and standby transmitter and receiver, while standby handsets are available which are used to by-pass all the distribution equipment and connect the controllers direct to the transmitter and receiver stations. There is also emergency hand-held equipment in the tower to provide the VHF channels should all the standby services suffer a complete breakdown. A self-contained emergency facility provides two VHF channels and can be switched to become a base station for controlling UHF-equipped vehicles. A transmitter receiver which can be switched to all VHF frequencies is also available.

All speech communication on the air-to-ground radio channels and operational telephone conversations are recorded in accordance with the standards laid down by the International Civil Aviation Organisation. The recordings are made on multi-channel recording equipment and the tapes are retained for 30 days after use so that they are available in case there is an incident which needs an enquiry. The tapes are examined from time to time to ensure a high standard of the control and radio telephone communications procedures and equipment, and reports on sample tapes give a quality control service.

The Telecommunications Equipment Room

Because of the close spacing of frequencies in the aeronautical radio band, the main transmitter and receiver stations are located sufficiently far apart to avoid interference. At Cardiff-Wales the transmitter station is in the control tower building, and the receiver station is about half a mile away.

Monitoring the ILS equipment

RADAR

The 10cm surveillance radar on top of the control tower ▶

A telecommunications engineer checks the process radar video ▼

The controllers in the Approach Control room use radar data derived from a 10cm radar. The 10cm surveillance radar is a primary radar which operates on the principle that energy transmitted through the radar aerial is reflected back from an echoing object, such as an aircraft, hill or building, and this 'echo' is received by the same aerial and presented as a 'blip' on the radar display tube. The target is entirely passive and the strength of the reflection depends on the size and type of the object and its echoing area. As only reflections from aircraft are required, unwanted fixed ground echoes and other interference are eliminated by electronic devices to present the air traffic controller with as clear and uncluttered a picture as possible.

All the radar information is displayed on a radar display system and enhanced by computer-generated video maps. These maps provide an extremely accurate indication of the runway's extended centrelines, the position of reporting points and other geographical data. Various maps are available for different purposes and the controller can select or enlarge part of a map.

◀ *The controller's radar display at Cardiff-Wales*

Checking the radar display for bearing and distance ▼

NAVIGATIONAL AIDS

INSTRUMENT LANDING SYSTEM

When the radar controller in Approach Control has positioned the aircraft on the extended centreline of the runway, the pilot may complete the approach by using the Instrument Landing System (ILS).

The ILS is a radio navigation system which transmits two beams, one – the localiser – operating on VHF, the other – the glide path – on UHF. The localiser beam defines the centreline of the runway and extends along the approach path for 20 miles.

The glide path beam defines the angle or glide slope which the aircraft should fly while following the localiser course to approach the runway, safely clearing all obstacles. When this system is coupled to the aircraft's flight control system, certain aircraft can make automatic landings in very poor visibility. To ensure the utmost reliability in any conditions, the ILS equipment has to be tested to a 10 million-to-one failure factor.

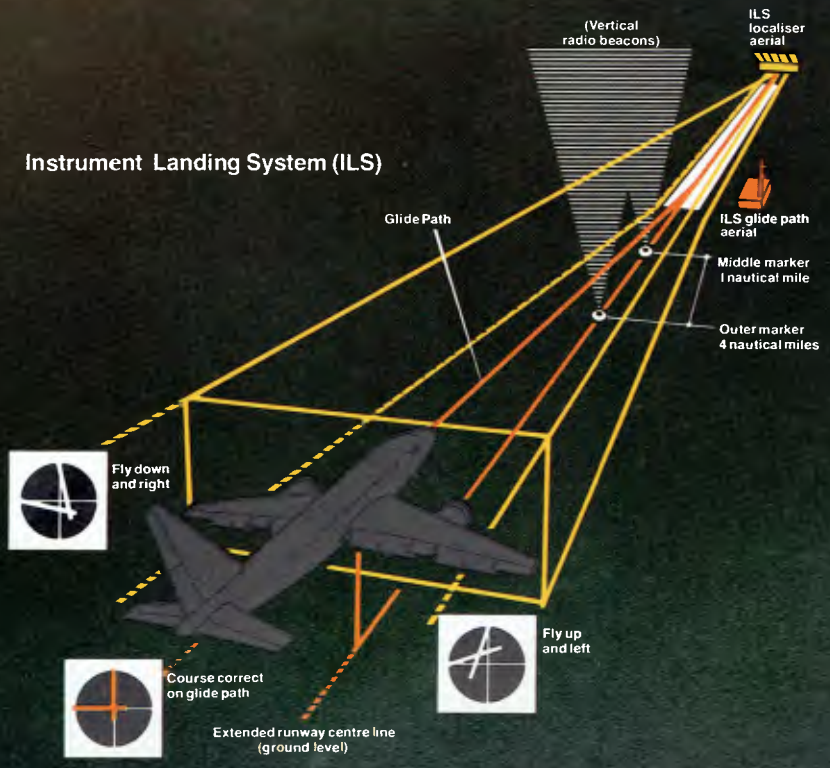
If the pilot wants to control his aircraft manually he can use the aircraft's ILS instruments to correct his position in relation to the glide path and centreline.

There are several internationally-recognised categories of ILS performance. The Category I system at Cardiff-Wales permits operations with a cloud base as low as 60 metres and a forward visibility down to 800 metres runway visual range.

The operational integrity of the ILS is checked at least every 90 days by the Civil Aviation Authority's Flying Unit using their own aircraft which are equipped to measure and check the accuracy of the ILS and other systems.

Doppler VHF Omni-range beacon (DVOR) gives a continuous bearing to aircraft flying to or from the beacon, and the pilot can use it either to obtain

The ILS glide path aerial



a bearing or for a course to fly.

Non-directional beacon (NDB) The pilot monitors the NDB radio navigation beacon and by flying the aircraft along a pre-set flight path, he can make an approach to the runway clear of high ground and obstacles.

Surveillance Radar Approach (SRA) The controller guides the pilot along the runway extended centreline marked on his radar video map. The pilot is advised of the height he should be flying for his range from the airfield. In this way, the pilot can make an approach to the airport through cloud.

Digital Resolution Direction Finding (DRDF) is available to Air Traffic Control to assist in the location of an aircraft. When an aircraft transmits a radio message on VHF, this signal is converted into a digital readout on a display, giving the controller the actual bearing of that aircraft from the airfield.

AFTN

International airline operations are supported by a worldwide point-to-point communications system, called the Aeronautical Fixed Telecommunications Network (AFTN) which is specifically for the use of the air traffic service. AFTN passes messages with a content and format laid down by the International Civil Aviation Organisation. Most developed countries have a main switching or relay centre feeding a national network of sub-centres and terminals.

CLOSED CIRCUIT TELEVISION

Closed circuit television is used to transmit and display information to both the control tower and approach operations rooms. It gives local weather observations ('weather actuals') and the elements of the meteorological forecast.

The ILS localiser aerial at the end of the runway

The automatic direction-finding radio receiver aerial

NATS also supply air traffic services at:

Aberdeen
Bedford
Belfast
Benbecula
Birmingham
Boscombe Down
Edinburgh
Farnborough
Gatwick
Glasgow
Heathrow
Inverness
Islay
Kirkwall
Manchester
Prestwick
Stansted
Stornoway
Sumburgh
Tiree
Wick

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