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THE METEOROLOGICAL FORECASTING OFFICE AT HEATHROW

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The Meteorological Forecasting Office at Heathrow

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The forecasting office at London (Heathrow) Airport closed in 1988 after nearly 42 years in the forefront of meteorological services for civil aviation. This account of 'Heathrow Met' groups the material under particular aspects of organization or output which in some cases extended over many years; the treatment is roughly chronological but with considerable time overlap between sections. No reference is made to observational matters.

Part I

Heathrow Met. established : the era of personal service

The Airport

Early in 1945, construction work started at Heathrow for a new RAF Transport Command airfield, consisting of a triangle of 2000-yard concrete runways and the usual wartime collection of temporary buildings; but before the airfield was complete, the war in the Far East came to an end and it was no longer needed by the RAF. A large increase in commercial flying was expected in peacetime, and although Croydon (the main pre-war civil airport for London) and Northolt were both opened for civil airline operations after wartime use by the RAF, at neither place was there much room for expansion. By contrast, the immediate surroundings of Heathrow were then still comparatively rural, and the Ministry of Aviation decided that the redundant RAF airfield would be a very suitable location at which to develop a new civil airport for London (Wymer 1963). The immediate post-war period in Britain was an age of austerity; the wartime slogan of "make do and mend" still applied and a great deal of improvisation was necessary. Food and fuel rationing continued for several years; building materials, furniture and office equipment were either unobtainable or in very short supply; until demobilisation was complete there were labour shortages which continued to some extent right through the 1950s due to call-ups for National Service. All these factors influenced the creation and development of services at the new airport. When Heathrow officially opened on 1 June 1946 there were no permanent buildings at all, and facilities for both passengers and staff were woefully inadequate; some departments including Customs and Immigration were even housed in caravans and draughty marquees (Wymer 1963). In these circumstances, Heathrow Met. was perhaps fortunate in being provided from the outset with a ridge roofed hut nearly 120 feet long and 24 feet wide.

The Original Northside Office

During the last week of May 1946, a dozen Met.Office staff were posted to Heathrow as the nucleus for what was planned to become a major independent forecasting office. Leading the team as S.Met.O. was Geoff Oddie, a PSO recently demobilised from war service as a Wing Commander in the Meteorological Branch of the RAFVR. With him came Eric Fielder to look after technical administration Alec Elder, Harry Heastie and Dixie Dean as forecasters, also two WAAF Corporals and five LACWs to provide assistant support. Full hourly observations started at 1800 Z on 31 May, and meteorological briefing was given for all flights leaving Heathrow as from its official opening on the following day. Fred Sharp and Jack Vince soon arrived to join the other three forecasters, also a further six LACWs, so that from mid-June 1946 a full 24-hour watch was maintained with one forecaster and at least two assistants on duty at all times.

The Met.Office hut formed one wing of the Airport administration and operations block which also housed the Aviation Information Service (AIS) and, in the luxury of a two storied brick box, Flying Control. Together with other buildings serving airlines and passengers, the operations block was located on the north side of the airfield,

just off the historic Bath Road and not far from the "Three Magpies" which in earlier days had provided refuge for some of the notorious highwaymen of Hounslow Heath. The various rooms, separated from each other by partition walls, were on the airfield side of the hut, access to them being by means of a corridor on the Bath Road side which also joined the wing to the rest of the block. Characteristically for those times, when the staff arrived, the Forecast Room furniture had not been built and for over two months everyone had to squeeze into a small Staff / Store Room and use portable benches borrowed from RAF Hendon.

The difficulties and frustrations of trying to establish a fully operational forecasting centre for civil aviation during the immediate post-war years comes over very clearly from the monthly Reports of Work sent to Headquarters. What today would be deemed trivialities not worth a mention were duly recorded as the milestones of achievement they were then perceived to be: such things as the provision of a second telephone in the Forecast Room in August 1946, the arrival in December that year of time-stamping machines, receipt of financial approval for local purchase of violet coloured pencils to mark occlusions on charts and the installation of a second light slope for upper air work in December 1948, only ten months after it had been ordered! Trying to obtain efficient chart copying equipment was a veritable saga. An enormous carbon-arc dieline machine arrived during the autumn of 1947, and improvisations to lift the quality of output continued for years, involving all sorts of expedients like Indian and various coloured inks for plotting, charts printed on tracing linen instead of paper, paper charts moistened with a turpentine soaked rag to increase translucency, and tinfoil reflectors inside the machine behind the arc lights. None of these was wholly successful, and it was a relief when the daily operational requirement by the airlines for copies of working charts ended in 1950; but the dieline still had to be used for other purposes until May 1959 when a more modern plan printer was at last obtained as a replacement.

Airline Operations

Three airlines took up residence at Heathrow from the beginning Pan American (PAA) and American Overseas (AOA) who merged in 1950, also British Overseas Airways (BOAC). Most of the internal and short haul traffic was then based at Croydon or Northolt and there were very few medium haul flights e.g. direct to the Middle East. By the end of 1946, TransCanada (TCA), Air France, British South American (BSAA) and Swissair had arrived, followed in 1947 by Sabena, KLM, Aer Lingus and Quantas. And so it went on; by 1950 Heathrow was already the busiest civil airport in Europe. Northolt was barred to civil traffic in 1954, and although Gatwick opened in 1958, Croydon finally closed in 1959. By 1960, no fewer than 44 airlines regularly operated from Heathrow and by the 1980s there were around 80. BOAC naturally based their centre for all operations at Heathrow as later did British European (BEA), the other national carrier who started operating from the Airport in 1950. In January 1948, AOA established their centre for all European operations at Heathrow, and PAA, TCA and Transworld (TWA) also subsequently did this.

Initially the types of aircraft in service were for the most part those used during the War or developed from them, such as Dakotas, Skymasters, Lancastrians, Yorks and a few Constellations, but the pace of development was rapid. AOA brought in their first Stratocruiser in August 1949 and five Heathrow Met. staff were taken on a 1¾ hour demonstration flight. In April 1951, less than five years after Heathrow opened, BOAC started test flying the Comet 1, and two Senior Forecasters later went on proving flights to both South Africa and Singapore. In 1955, PAA started DC7 services direct to New York, and from December 1957 Britannias operated by BOAC and El Al were flying to New York and Montreal at altitudes up to 30,000 feet; by 1958 both Comet 4 and Boeing 707 were regularly flying schedules direct to New York at 40,000 feet.

In planning and executing safe and economic operations during the 15 or so years after the end of the War, civil aviation depended heavily on meteorological information and advice. Automatic landing techniques had not then been developed and the airlines perforce took a keen interest in weather reports and terminal

forecasts (TAFs) for destinations and alternates. The limited range of many aircraft necessitated careful operational planning, especially for transatlantic flights, and this involved much discussion and analysis of upper air charts. The operational importance of meteorology to the airlines during this period is underlined by the fact that several of them employed professional meteorologists, not only in a central planning role but in support of daily operations. This was done briefly, for example, by Skyways at Dunsfold. PAA deployed meteorologists as part of their operational units in several countries where the national meteorological services were at the time unable to provide all that PAA deemed necessary; as described later, this even happened briefly at Heathrow during 1948. PAA meteorologists also produced some useful monographs, e.g. "The North Atlantic Jetstream" (Buxton and Chandler 1956).

This background of airline dependence on meteorology naturally led meteorological staff to become directly involved in airline operations. Frequent and friendly personal contacts between meteorologists and the airline personnel they served were a characteristic and rewarding feature of that era. Individual attention was given to, and specific documentation provided for, each and every flight, and in most cases aircrews were also given personal briefings before take-off by the forecaster who had prepared the forecast. By long tradition these briefings normally took place in the Forecast Room, and this custom persisted for many years after the War because it was convenient and was valued by both sides. But the practice had obvious implications for both accommodation and staffing levels, and by the late 1950s the number of daily departures reached the point where individual service on this scale became impossible; fortunately by this time developments in both aircraft and operating procedures were reducing the need for such a comprehensive meteorological service. Reductions in work load are always welcome, but in this particular case there was a bitter-sweet quality about the change because the direct involvement of meteorologists in airline operations also diminished; sadly, personal relations and the sense of partnership were never again quite as close.

A partnership implies mutual help, and the airlines could see for themselves that observations made in flight formed an important element of basic meteorological data. Reports, both in-flight and post-flight were contributed by aircrew on a largely voluntary basis; to encourage regular reporting and as a gesture of appreciation, it was decided in 1955 to institute annual awards by DG Met.O. to Captains and Navigators who had been outstandingly helpful during the year. This arrangement continued until 1976. Aircrew also generally welcomed the opportunity of discussion provided during familiarisation flights (see later).

The Civil Aviation and Airport Authorities

Since the War, responsibility for civil aviation affairs has been vested in a succession of Government Departments Ministry of Aviation (MOA), Ministry of Civil Aviation (MCA), Ministry of Transport and Civil Aviation (MTCA), Board of Trade (BoT), Department of Trade and Industry (DTI), and Department of Transport (DOT). Since 1972, this charge has been exercised through the Civil Aviation Authority (CAA) which covers not only matters such as air safety, licensing, air traffic and air information services but also meteorology (CAA 1985). However, although CAA does own and manage eight Scottish airfields (mostly in the Northern and Western Isles), it is not responsible for airports in general, nor in particular for Heathrow which since 1965 has come under the British Airports Authority (BAA). The Meteorological Authority for civil aviation in the UK is thus the CAA and not the Met.Office.

In order to determine what meteorological services are needed, the CAA seeks the views of airlines and other aviation user interests (for example by means of the British Civil Aviation Standing Conference); having no meteorologists on its payroll it also takes professional advice from the Met.Office, whom it then engages to provide the necessary services on a repayment, agency basis. Thus although Heathrow Met. was manned and run by the Met.Office at the Airport, it is in no way part of BAA; it was created and developed for the benefit of civil aviation at the expense of CAA and its Ministry predecessors. The fact that Heathrow Met. was not, strictly, master in its own house had little effect in practice during the first 20 years; but the introduction of

BAA and CAA with all their attendant financial controls into the administrative structure undoubtedly made life more complicated, as will emerge in due course in this narrative.

Gathering and Distributing Meteorological Data

When Heathrow Met. was established in 1946, the efficient and well-oiled meteorological telecommunications of today did not exist. Within the UK, observations were mostly collected by teleprinter, though until December 1947 Heathrow reports had to be telephoned to collecting centres at Uxbridge or Harrow Weald for onward transmission to the national meteorological communications centre, then known as ETA, at Dunstable; ETA then distributed all UK reports country-wide on a teleprinter broadcast known as Channel I. Almost all overseas data were obtained by interception of national W/T broadcasts at Dunstable and elsewhere, and European / Mediterranean reports were disseminated by ETA on a separate Channel II broadcast; North American data received at Prestwick were not at first generally distributed. From the outset, Heathrow received both Channel I and Channel II broadcasts and also North American data sent on a direct line from Prestwick; similar direct lines were also soon installed from Gloucester and Uxbridge who passed to Heathrow as well as to ETA all the data they collected by W/T interception. Inevitably, this multiplicity of sources implied duplication of information, but only by having several irons in the fire could Heathrow be assured of receiving promptly all the basic data needed. These initial ad hoc arrangements were steadily improved after the establishment under WMO aegis of the International Meteorological Teleprinter Network in Europe (IMTNE), but it was many years before North American data were received reliably at all times, and this caused many problems in forecasting for transatlantic flights. The W/T link between Prestwick and Canada was dropped in April 1950 in favour of scheduled radio-teletype (RTT) broadcasts which had by then started. The RTT circuit came from Montreal via the Azores and Paris; it was good when it worked but was unfortunately very susceptible to breakdown whenever radio communications were affected by sunspot activity. Many cris de coeur about this were sent to Headquarters throughout the early 1950s, and the problem was not solved until late in 1956 when a cable circuit from Montreal to the UK came into use; this operated until the end of 1967.

There were similar teething troubles for some years with operational meteorological (OPMET) data. The airlines required, both in the air and on the ground, near-current actual reports, together with TAFs, and until ICAO took matters in hand it was left to individual forecast centres to assemble what was needed. Basic meteorological data provided a bare skeleton of hourly or 3-hourly actuals, but TAFs from other countries had to be obtained by Aeronautical Fixed Telecommunications Network (AFTN) signals following arrangements made on a bilateral basis; many requests went unanswered, and occasionally the airlines themselves had to bring pressure to bear locally through their overseas operations offices. What developed into the routine of regional VOLMET broadcasts started in March 1947; these were transmitted every half hour by W/T (later also by VHF R/T) and contained both actuals and TAFs. At first, the broadcasts covering Southeast England were hand keyed by MCA wireless operators based at Heathrow Met. who assembled the necessary information, but this commitment passed to ATCC Uxbridge in May 1949. However, the W/T operators remained at Heathrow Met. until February 1955 to intercept other VOLMET broadcasts, thereby obtaining much of the OPMET data needed locally.

The number of telephone requests from airlines for up-to-date OPMET data became an embarrassment very soon after Heathrow Met. opened, and it was realised by July 1946 that something would eventually have to be done to make this information available to the airlines on a routine basis, 24 hours a day. In the autumn of that year, AOA dispatchers were authorised to visit the Forecast Room as necessary to extract OPMET data from message files on a self-help basis, and similar arrangements were subsequently agreed with PAA, KLM, and other airlines; attempts were also made to persuade overseas originators of AFTN signals to add airlines to their list of addressees at Heathrow. But these were only palliatives and the problem was not solved until December 1947. A Company Met. Broadcast by

teleprinter was then inaugurated, operated from the Met. W/T Room by MCA teleprinter staff who sent out data which Heathrow Met. had to assemble; this broadcast was available on subscription to any airline at Heathrow, and all the major carriers opted for connection. Just as WMO had organised IMTNE for the exchange of basic meteorological data, ICAO later made similar arrangements for OPMET data by setting up the Meteorological Operational Teleprinter Network in Europe (MOTNE) which started on 1 April 1960. UK data were collected on a conference network, and data from all countries in Europe were disseminated on separate MOTNE Broadcast circuits. From August 1960, all airlines taking the Company Met. Broadcast were also connected to the MOTNE Broadcast; the content of the former was then drastically pruned to exclude European data, thereby saving Heathrow Met. a considerable amount of data sorting work. The MOTNE system worked very well, and in November 1967 was expanded by the introduction of a third channel.

Establishment of Atlantic and Upper Air Forecasting

It was clearly envisaged from the outset that Heathrow Met. would develop into a major civil aviation forecasting centre, dealing with transatlantic as well as continental flights. No doubt for this reason, although at this time there were no services from London direct to North America, the surface plotting routine for main synoptic hours established in August 1946 made use of Atlantic charts on a scale of 1:15 million. The initial team of five forecasters, who were a mix of various wartime and peacetime grades, covered all aspects of the work; but when a second roster was introduced in November 1946 the senior of the two on duty, at SSO or SXO level, took overall charge and remained personally responsible for the primary Atlantic chart analysis. During these early days, most flights to North America staged through one or other of the established transatlantic terminals at Prestwick and Shannon; there might be general discussion about the subsequent oceanic leg, but flight forecasts were provided only to the first stop. A few aircraft staged through Keflavik and were given documentation and briefing for this leg, but at first these forecasts were prepared only under guidance from Prestwick Met. On two occasions in 1947, when RAF aircraft flew directly from Heathrow to Gander, documentation was prepared by the meteorological office at HQ 46 Group, Transport Command, and one of their forecasters came over from Harrow Weald to give the briefing. It was not until the summer of 1947 that staff levels had increased sufficiently to expand the plotting routine to include surface charts for the intermediate synoptic hours, also 700 and 500 mb charts twice a day and charts of aircraft reports (AIREPs) over the Atlantic. From late August, following a liaison visit by S.Met.O. and two of the senior forecasters to the Upper Air Unit at CFO Dunstable to discuss upper air prediction techniques, 700 and 500 mb forecast charts were prepared twice daily on an experimental basis. By this time, the long-haul airlines were contemplating direct flights from Heathrow to Canada, and that autumn there were several discussions with them about the service required.

Met.Office Headquarters accepted that independent transatlantic forecasting which involved the preparation of both surface and upper air forecast charts could not possibly be undertaken by one man, and that the levels of both responsibility, and the technical expertise that would be required, justified a Senior Forecaster at PSO level, together with an Upper Air Forecaster of SSO or SXO grade. Unfortunately, due to the post-war shortage of manpower, the staff needed to implement this policy were not immediately available, but a very modest start was made in January 1948 when it was agreed to prepare and issue 700 and 500 mb forecast charts to the airlines twice a day for planning purposes, together with a copy of the latest actual surface chart. Independent transatlantic flight forecasting also commenced at Heathrow that month when documentation and briefing were provided for a single PAA service daily, direct to Gander; the following month forecasts were also issued to BOAC for a once-weekly service to Montreal using flight refuelling, and from March to TCA for services to Keflavik or Santa Maria.

This full forecast service was initially offered only for departures from Heathrow between 1700 and 2000 Z each day, a constraint which was naturally not welcome to the airlines. As there seemed little prospect of an early end to the staff shortage,

PAA asked for permission to deploy one of their own operational meteorologists in the Forecast Room to prepare forecasts and brief aircrew for PAA flights departing at times outside the 3-hour time slot for which Heathrow Met. could itself provide the service; after approval by HQ, S. Met. O. agreed to this most unusual procedure which started in May 1948. With the arrival of some of the long awaited staff, from mid-June 850 mb charts were added to the plotting routine and flight forecasts were offered for all departures during the 9-hour time slot from 1300 to 2200 Z daily. The remaining staff needed came in July, intermediate hour upper-air charts were introduced, and from mid-August, Upper Air Forecasters were rostered on a 24-hour basis to analyse the 700 and 500 mb charts properly by gridding from 1000 mb, and to produce forecast charts in a similar manner using surface prebaratics prepared by the Senior Forecaster. Heathrow Met. then started providing full documentation and briefing for all transatlantic flights, and the PAA meteorologists were withdrawn in September 1948. The new Senior and Upper Air Forecaster posts were not all filled by the correct grade of staff until two years later, and indeed certain individual XOs who had become very experienced at upper air work continued to do this throughout the 1950s.

The normal practice of preparing forecast charts for some specific fixed time ahead is clearly unsatisfactory for flights lasting 12 hours and more, because in any mobile situation the positions of weather systems and their associated fronts and bands of strong winds cannot possibly be correct at all points along the route. To overcome this problem, the idea of radially composite charts was developed. On these, fronts and isopleths are marked in the positions they are expected to occupy at the time when an aircraft arrives there, travelling in any direction from its departure point at some assumed ground speed. For westbound flights, such a procedure reduces the spacings between weather systems in a westerly situation, so there is an obvious risk that wind gradients implied by the isopleth spacing might be incorrect. An experimental chart of this kind was prepared post facto at Heathrow in September 1947 for a Canberra flight from Washington to Shawbury; this was examined closely by Mr Sawyer in Met.O. 9, who found the procedure acceptable. After discussion with forecasters and operators at Heathrow, it was decided to introduce composite charts as a routine in October 1948 in place of the traditional fixed time charts. The assumed ground speed was 200 kts which was appropriate for the types of aircraft then flying; this implies a time difference of about 12 hours between the UK and the eastern seaboard of Canada. The forecasters quickly adjusted to the new thinking required for this type of forecast chart construction, and the operators liked the new presentation, unanimously confirming this view both in 1950 and again in 1955. The introduction of these composite charts was an important landmark of true independence for Heathrow Met. as a forecasting centre, because they were in no way comparable to the fixed time charts prepared by CFO.

Composite forecast charts for the surface, 700 and 500 mb levels were prepared four times a day; each issue covered departures from Heathrow during a 6-hour time slot and copies were issued to the airlines for planning purposes 2½ hours before the beginning of each validity period. These charts were awaited with impatience by the flight dispatchers whose job it was to work out optimum routes which were carefully selected to avoid strong headwinds whenever possible; frequently this involved flying well to the north of depressions in mid-Atlantic, covering substantially greater distances than those on the minimum distance great circle track, but in less time and therefore with less expenditure of fuel. If there were strong headwinds that could not be avoided, flights had to be staged via Keflavik or occasionally Santa Maria.

The transatlantic flight dispatchers were the most frequent and regular visitors to the Forecast Room, calling to collect and discuss the forecast charts and the TAFs for destinations and alternates. Not surprisingly, many of them became part of the office 'family' and were automatically included as such if an assistant went to the canteen for a tray of tea; one TCA dispatcher who came from a Newfoundland fishing family could sometimes be found on winter nights sitting on a radiator, a cup of tea beside him, busily knitting while waiting for the chart issue! For efficient flight planning it was essential for there to be a close rapport between forecasters and dispatchers, and

relations with staff from BOAC, PAA and TCA were particularly close. The fact that Heathrow Met. encouraged dispatchers to visit the Forecast Room regularly to root things out for themselves and to discuss relevant points with the forecasters personally was much appreciated, and in an unsolicited comment PAA indicated in 1960 that from their point of view the service at Heathrow Met. was the best anywhere in the world, not excluding New York (Buxton E. B. personal communication).

As soon as their flight analyses were complete, the dispatchers passed details of tracks chosen to the Forecast Room; the Senior Forecaster then prepared a pictorial cross-section for each route showing clouds, freezing level, icing etc., below which the Upper Air Forecaster inserted winds and temperatures at three levels (850, 700 and 500 mb) for each 5º longitude zone. The flight folder assembled as documentation contained copies of the forecast surface, 700 and 500 mb charts, the cross-section / zone winds and a sheet of TAFs for destination and alternates; the crew collected this when they arrived for briefing by the Senior Forecaster an hour or so before take-off.

Until the introduction of the Britannia aircraft on the transatlantic run in December 1957, a large proportion of daily flights departed between 1600 and 2200 Z, causing a marked congestion of briefings during the late afternoon, just at the time when the Senior Forecaster had to prepare his surface prebaratic for departures during the next 6-hour time slot. As the traffic increased, it became difficult and sometimes impossible to complete this task in time for the Upper Air Forecaster to produce his forecast 700 and 500 mb charts on schedule. Another pair of hands was needed during the critical time and fortunately a partial solution emerged in May 1952 when BOAC started its scheduled Comet service to Rome. In view of the pioneering nature of these first passenger flights by jet aircraft at high altitude, it had been decided to roster an extra Forecaster to deal exclusively with them; by mid-afternoon, that task was normally complete and the forecaster was then free to move to the Atlantic bench where he assisted with documentation and briefing and enabled the Senior Forecaster to concentrate an chart work without interruption. This help proved to be invaluable, and not long afterwards an SXO was rostered each day as an Atlantic Forecaster. With more time available, it then became a challenge to discover the predilections of individual Captains (such as the famous O.P.Jones, who had flown with Imperial Airways from Croydon during the 1920s and 1930s - see Cluett *et al*, 1980) and to prepare appropriate material in advance. As with the dispatchers, the provision of a truly personal service was a stimulating and rewarding feature of the job at this period.

One particular transatlantic flight during the early 1950s deserves special mention. In October 1953, BOAC flew HM the Queen direct from Heathrow to Montreal. As the first Royal Flight across the Atlantic, over a much longer stage length than was normal at the time, this naturally caused a great deal of interest and a wish on the part of everyone to make sure that all went well. The S.Met.0. decided to roster extra Senior and Upper Air Forecasters to deal exclusively with this flight, to prepare special charts for its specific departure time and to handle all the many enquiries expected from the press as well as from operations staff. Thankfully, everything worked splendidly and the aircraft arrived in Montreal within two or three minutes of flight plan a gratifying testimonial to the strength of the gridding technique for upper-air work and indeed to the validity of composite charts.

Early flight forecasting arrangements for Eumed routes

Although Heathrow Met. provided documentation and briefing for all flights from the outset, until things had settled down it operated as a dependent forecasting office, working with the aid of advisory forecasts and general guidance from Uxbridge and Gloucester concerning European and Mediterranean (Eumed) flights; once the 24-hour chart routine had been established in August 1946 it took over independent responsibility for these flights. For some time however, it remained the custom for the departure and destination forecasting offices to exchange advisory forecasts

covering the second halves of medium-haul routes, for example to West Africa or the Middle East; arrangements for these exchanges were set up on a bilateral basis.

From November 1946 a second forecaster at XO level was rostered each day except during the evening lull period. This new post was made responsible for Eumed flights and until November 1949 for local forecasting also; an independent set of European charts on a scale of 1:7·5 million was also introduced. Documentation for internal and short-haul flights consisted of a form on which visibility, cloud, en-route weather, freezing level, icing and upper winds and temperatures were set out in tabular form, together with a sheet giving TAFs for destination and alternates. For medium-haul flights, a pictorial cross section along the route was provided as for Atlantic flights instead of the tabular forecast; until August 1956 a fixed time forecast surface chart was also included in the documentation. The 700 and 500 mb actual charts drawn by the Upper Air Forecaster covered the whole of Europe as well as the Atlantic and North America, but the forecast upper-air charts then covered the Atlantic and continental fringes only; the Eumed Forecaster therefore prepared his wind and temperature forecasts largely by extrapolation from the actual charts.

The work load on the Eumed Forecaster increased steadily, but the effects of this were for a time offset by the introduction of a Local Forecaster on a full 24-hour basis in November 1949 (see later). However, by the autumn of 1953 there were 30 or more Eumed departures a day and it was evident that the Eumed Forecaster could not possibly cope with the large additional burst of activity expected in connection with the London to New Zealand air race. A special forecasting unit was set up temporarily to deal with this. The closure of Northolt to civil air traffic the following year brought a large and permanent addition to the departure schedules, and with the arrival of some of the Northolt staff it became possible to split the Eumed work; one forecaster then dealt with all flights to the Mediterranean, leaving his colleague responsible for European services only.

The new Northside Forecast Room

The original accommodation plan for Heathrow Met. allocated a separate Briefing Room alongside, but not directly connected to, the Forecast Room, and the room was used experimentally for that purpose on several occasions during the early years. But neither forecasters nor aircrew particularly liked this arrangement, primarily because it was so difficult to ensure that relevant material was always readily to hand. For this reason, in accordance with tradition, crew briefing continued in the Forecast Room which was low pitched, only some 25 feet wide and less than 20 feet deep. By early 1947, six or seven staff were on duty there at a time and briefings had increased to 15 or 20 a day, many of these concentrated into rush periods. Congestion became a problem and the airlines were asked to restrict the numbers from each crew who attended the meteorological briefing. The situation was exacerbated by not only occasional pre-arranged parties and visitors having a specific interest in meteorology but also 'sight-seeing tours' organised and escorted by Airport staff as part of a public relations exercise to publicise Heathrow; despite repeated protests by the S.Met.O. these continued through 1947.

By the turn of that year, a dozen or so staff were on duty simultaneously, briefings had increased to 35 or 40 a day and working space was becoming inadequate. Plans were therefore prepared in February 1948 for a new Forecast Room to be built on the airfield side of the original wing, and after a long wait to obtain financial approval, construction eventually started in January 1949. Essential building work and bench construction were completed by October 1949 when the room was taken over, but work on minor fittings and decorations lasted until May 1950.

After the cramped and somewhat claustrophobic environment of the old Forecast Room, the new quarters must have seemed almost palatial. The room was about 40 feet wide and 25 feet deep, also roughly twice as high as the old office, with windows on two sides. Until venetian blinds were fitted, months after the room was occupied, light-table work on the upper-air bench was very difficult on sunny days, but at least one had the compensation of splendid views across the airfield on which colonies of

hares could often be seen.[1] There was a large rectangular skylight which gave a welcome improvement in lighting and ventilation but was also the source of cold and draughts on winter nights. There were persistent complaints about this and the problem was not solved until nearly 10 years later, shortly before the move to the Queens Building office in the Central area; it was then grudgingly admitted by the heating engineers that the heating pipes round the skylight had been fitted incorrectly, so that there had been no hot water circulation at all through that part of the system!

As part of the new Northside building, an excellent Observing Office was added adjoining the Forecast Room, also a larger room to house the MCA wireless and teleprinter operators. Additionally, once the move had taken place, various alterations were made to the original building. A small skylight was fitted in the old Forecast Room which certainly improved the ventilation and gave a little natural light, but was prone to leaks in wet weather. This room was brought into use again in 1953 for the New Zealand Air Race, and in 1954 became the Mediterranean Room. For the first time separate male and female Staff Rooms were also provided, replacing the original arrangement under which both sexes had to share one room with piles of stationery and stores.

The Local Bench

For over 18 months after the Airport opened, TAFs for Heathrow were prepared and issued independently by forecast offices at Gloucester and Uxbridge as well as by Heathrow Met. itself. Not surprisingly, this practice led to some embarrassing conflicts of opinion and the problem was not solved by post facto exchanges of TAFs issued. Telephone conferences having been such an established and useful feature of wartime meteorology, e.g. in RAF Bomber Command, it is difficult to understand why they were not introduced from the outset in the post-war civil aviation field. A civil aviation meteorological conference was at last inaugurated in May 1948, the participants being Heathrow, ATCC Uxbridge, Northolt and Croydon; these took place prior to the major 6-hourly TAF issues and the agreed story formed the basis for them regarding timing and general synoptic developments. From this time, Gloucester no longer originated Heathrow TAFs, but until 1951 a general liaison between civil aviation and RAF Transport Command was maintained by means of a once-daily conference between Heathrow, Uxbridge and Gloucester. By the mid-1950s, both Croydon and Northolt had dropped out of the conferences, but discussions with Uxbridge four times a day continued for many years. In April 1968, Gatwick joined the conference, as did Stansted not long after that. In November 1949, new posts at XO and SA level were added to the complement to man a separate local forecasting bench in the new Forecast Room where there was space for it. Hourly British Isles charts were plotted, and the Local Forecaster then took over responsibility for all local area forecasts and TAFs originated at Heathrow and for the conferences; the Senior Forecaster was consulted as necessary. The so-called 'long TAFs' covered 24-hour periods and the 'short TAFs' 6 hour periods; together these provided both for flight planning and for aircraft in flight. In April 1959 the new concept of TREND forecasts was introduced, primarily for in-flight purposes; these were appended to each hourly observation and indicated changes significant to aircraft expected during the next two hours. The short TAFs were then extended to cover 9-hour periods which took care of most flight planning requirements for short and medium haul flights; the long TAFs continued to cover 24 hours ahead but were needed only for the long haul flights, especially on transatlantic routes, and were therefore given a more restricted distribution.

[1] The curious predilection of hares for busy airfields in many parts of the world has often been noted; there is even on record one remarkable instance when an airfield frequented by hares was closed for repairs and the hares migrated to the nearby satellite field that was temporarily brought into use where previously there had been no hares. See Evans, G.E. and Thompson,D.: "The Leaping Hare" 1972.

Heathrow Met. was the civil aviation Main Met.Office (MMO) for the south-eastern part of England, and 24-hour TAFs for other airfields in this area were also originated by the Local Forecaster at Heathrow. At those stations with dependent forecasting offices (i.e. at various times Hurn, Bovingdon, Blackbushe, Stansted, Croydon and Gatwick), the long TAFs originated at Heathrow provided the essential MMO guidance concerning general weather and timing; when an outstation forecaster was on duty, he normally prepared short TAFs on the spot, but in his absence these too had to be originated by Heathrow. For busy airfields where there were no forecasters (e.g. Southend from the late 1950s and Luton from the early 1960s), all TAFs needed were prepared by the Local Forecaster at Heathrow, who thus had to know a great deal about the local meteorological characteristics at many different places. The combined experience of many forecasters at Heathrow and elsewhere was after some years distilled into a comprehensive "Local Forecaster's Gen Book" which set out in some detail all the relevant information; this was completed in January 1956 and was revised in June 1959 and subsequently as necessary.

The Local Forecaster also handled all enquiries concerning UK weather and dealt with Internal flights, preparing documentation and giving briefings as necessary; he also normally looked after the Eumed bench during the evening lull period when that was unmanned. When the Southern ATCC was set up at West Drayton in April 1955, a small meteorological unit manned by assistants was set up there to provide OPMET data for the controllers, but it was decided that special arrangements would have to be made to give them meteorological briefings. Three times a day, when the controllers changed shifts, the Local Forecaster at Heathrow was taken over to West Drayton in official transport to do this, and this procedure continued for well over a year; in June 1956 the controllers decided that telephone briefings on request would suffice.

Any account of Heathrow Met. during the 1950s and early 1960s would be incomplete without some reference to the local forecasting problems caused by smoke pollution. The primary sources of smoke at Heathrow were domestic, and Local Forecasters ignored at their peril the social factors which, for example, led to serious visibility deteriorations during the late morning on Sundays and during the evenings on 5 November each year. The infamous smog of 1952 reduced visibility at Heathrow to literally no more than a few yards for long periods, and staff had immense difficulties in getting to and from the Airport. Some were marooned at the office and worked 24-hour shifts, others arrived many hours late for duty, having abandoned cars and walked 5 to 10 miles with great difficulty, particularly at road junctions and roundabouts. One unfortunate worker from another department in the same building lost his way en route to the MCA canteen which was in a hut, less than 50 yards away; he then spent several hours wandering around somewhere on the airfield. The passing of the Clean Air Act in 1956 was indeed a Godsend, and after 1962 there were no more dense smogs at Heathrow.

The potential consequences of seriously incorrect TAFs at a busy international airport like Heathrow are considerable, so the responsibility of preparing them is heavy. The Local Forecaster post was graded XO, no doubt on the grounds that more senior staff were in theory always at hand for consultation. But all forecasters were occupied with their own tasks and the Local Forecaster in practice had to make his own decisions, not only concerning Heathrow itself but often for its outstations which were used as alternates. During the late 1950s and early 1960s, several attempts were made by C.Met.O. to have the post upgraded to SXO; this was at last agreed in 1962 after the MMO had moved to the Queens Building.

In-flight Meteorological Watch

Throughout the period when scheduled passenger flights across the Atlantic were being established as a daily routine, using aircraft of limited range, the airlines were naturally concerned to monitor the progress of individual flights and to ensure that safety was paramount. Upper-air forecasting covering the long oceanic leg was in its infancy, and Captains on the flight deck needed up-to-date information which confirmed, or if necessary amended, that on which their flight plans had been based;

in extremis they could then for example abort the flight before the point of no return (PNR) was reached or on eastbound flights decide to make an unscheduled landing at Shannon or Prestwick. A very limited form of flight watch for eastbound AOA aircraft was started during the summer of 1948 and after discussions between Heathrow Met. and the transatlantic operators, it was agreed in April 1949 that a new procedure of In-flight Meteorological Watch would be introduced as soon as possible. Once again however, just as with the start of 24-hour Atlantic forecasting, Heathrow Met. was unable to obtain the extra staff needed to implement this exacting new task, and this remained the position for a further 12 months. At this stage, BOAC became so concerned that they offered to loan five Navigators to Heathrow Met. for up to 6 months to work in the Forecast Room and get the new service fully established; this unprecedented arrangement started in May 1950.

Copies of the flight plans for all eastbound and westbound flights to or from Heathrow were signalled to Heathrow Met. where the tracks were plotted on individual progress charts for each aircraft, together with the PNRs and estimated times of arrival (ETAs) at various points along the route. During the flight, hourly position and weather reports were sent by radio and were plotted on the progress charts; one could then see at a glance whether the aircraft was running early or late on flight plan, what weather was being experienced and in particular what winds were being computed by the Navigator on the flight deck. One hour before each aircraft reached its PNR on an eastbound flight (usually near 30º W), the Upper Air Forecaster prepared up to date winds (QAOs) for the aircraft 'flight level for each of the six 5º zones from 30º W to Heathrow, and these were signalled to the aircraft. The new procedure soon settled down, providing the airlines with the monitoring system they needed and Heathrow Met. with a great deal of useful information to supplement the skeleton of radio-sonde reports from the Ocean Weather Ships. The responsibility of flight watch work clearly merited an SSA grading, but as staff at this level were still not available, two or three experienced assistants were selected from each watch and were trained in the procedures by the BOAC Navigators during the summer months, formally taking over in September 1950 when the Navigators were withdrawn; the flight watch roster was not fully manned by SSAs until 1952.

As the number of transatlantic flights increased, so too did the provision of QAOs for eastbound services. By the summer of 1958, an average of over 25 were being issued each day, with a heavy concentration between 0500 and 0700, at a time when the Upper Air Forecaster was fully occupied with forecast chart construction. As the aircraft involved were by this stage much less subject to restrictions of range than previously, the need for routine issue of QAOs to all aircraft was questioned. After discussion, BOAC and PAA agreed that for a trial period starting in August 1958 QAOs should only be sent when specifically requested by a Captain in flight; the experiment was a success, and in October 1958 all the transatlantic airlines accepted this procedure on a permanent basis. This brought an immediate drop to an average of barely four QAOs a day, even on the summer schedules. The maintenance of individual progress charts as the cornerstone of In-flight Meteorological Watch continued for a further three years until the operators agreed that this was no longer needed, at least on a routine basis. Having played an interesting and operationally useful part in the development of transatlantic passenger services, flight watch was finally laid to rest in December 1961.

Manning Problems

For many years, Heathrow Met. was bedevilled by manning problems; indeed, impassioned and justified pleas for more staff stand out as the leit motif of monthly Reports of Work from the late 1940s right through to the mid-1960s when the complement reached its peak of around 180. In order to maintain essential services, staff of all grades had to work overtime over long periods, and at one stage the Treasury put a limit on this. At times of crisis due to sickness or the posting of staff without replacement, there was sometimes no alternative to cancellation of, and even recall from approved leave. Yet despite all these measures, there were occasions when agreed services and procedures had to be suspended temporarily

or could not be implemented as was the case with the start of both full Atlantic forecasting and Flight Watch.

Some comment must be offered on such a key feature of Heathrow life which seems to have come about from a combination of factors, some national and others specific to Heathrow. During the post-war decade, the Meteorological Office had to recruit and train very large numbers of assistant staff to replace those leaving the service on demobilisation (Ogden 1986). The difficulties were also exacerbated by the gradual reduction in the standard working week from 45½ at the end of the War to 41 because this increased the number of people required to maintain 24-hour rosters. A further problem affecting all stations where the operational work load increases is that staff complements inevitably lag behind those needed; moreover, when a requirement for additional posts is officially recognised by the establishment divisions, there is normally a further delay before staff can be found to fill them. A significant factor affecting forecasting grades was the amount of work required from them over and above their roster duties on the bench; this will be discussed in a separate later section. But the most worrying and persistent shortages were in the assistant grade where the shortfall at times rose to over 25% of established complement; moreover, of those in post some 10-20% might be new arrivals who were not fully effective because they had not been trained in all the local procedures. This state of affairs continued well into the 1960s when for a time SSAs and even forecasters had to be employed on assistant duties in order to get the work done. It cannot be denied that Heathrow acquired a poor reputation amongst assistant staff serving elsewhere, many of whom were extremely reluctant to accept postings to the Airport and threatened resignation if the move were pressed; at times of overall shortage in the grade, this stance naturally carried weight and added to the difficulties of Met.O.10 in trying (not always successfully) to provide Heathrow with its fair share of available resources. It became widely known 'via the grapevine' that assistant duties at Heathrow were no sinecure and that considerable overtime might also be required. This did not appeal to those who wanted a quiet life, nor did the prospect of moving to the fringe of London with a higher cost of living and the difficult problem of finding domestic accommodation. Although limited numbers of both sexes could be billeted at the Airport in staff hostels, that type of life is not to everyone's liking; moreover, the hostels were under threat of closure from 1952 onwards, despite repeated representations by the S.Met.O. and later C.Met.O. which helped to keep them open. In an attempt to attract new staff who could live at home, talks were given at local schools and many potential recruits were shown round the office, but the limited success of this approach was not enough to solve the problem.

Faced with these difficulties over obtaining staff, it was vitally important to minimise resignations among those in post. Fortunately, despite its growing size Heathrow Met. remained at heart and in style an outstation rather than part of Headquarters. As a deliberate policy, assistants were encouraged after appropriate local training to carry out all the duties on a watch, thus providing a welcome variety in the work and increased job satisfaction. The fact that everyone was contributing to an important and much appreciated service was apparent to all from the stream of aircrew and airline personnel coming to the Northside Forecast Room; many regular visitors used to chat to staff of all grades, one outstanding ambassador being Emile Bouderie, UK Manager of Air France who still "radiated Gallic charm" as he had done before the War at Croydon Airport (Cluett et al 1980). Staff who settled down at Heathrow therefore found the office atmosphere congenial despite the hard work involved, and this is attested by the attitude of assistants posted on temporary duty to CFO Dunstable during an acute staff crisis there in 1949; motivated by experience rather than hearsay, they all contrived to return to Heathrow on the day following their agreed three month stint at CFO on threat of resignation if this were not arranged a directly opposite view about Heathrow to that current on the grapevine.

An important contribution to staff morale was also made on the social side. A good spirit developed amongst staff of all grades, and the office soon became large enough to organise its own leisure activities. Cricket matches between teams of forecasters and assistants followed by an evening at a local hostelry became an annual feature during the 1950s and tennis tournaments were arranged on public

courts at Hounslow; theatre outings, parties and dances all became regular events. In September 1977 Heathrow Met. had a visit from 50 French meteorologists and their wives; a buffet lunch was arranged for this occasion, followed by a football match during the afternoon.

One particularly unpleasant feature in the Northside Forecast Room was the cloud of dust raised daily by the cleaners.[2] This was rightly found obnoxious and complaints were made by staff and S.Met.O. for some years until in January 1957 an assistant developed active pulmonary tuberculosis. It was believed that the virus was harboured by dust, and on the advice of the Airport Medical Officer all staff were offered an immediate chest X-ray at the Middlesex Hospital. Fortunately no other cases occurred and as an indirect bonus there was an immediate improvement in cleaning practice involving a liberal application of wet tea leaves before sweeping! The office environment again became a matter of great concern in the Queens Building Office during the late 1960s and throughout the 1970s; this is described in a later section, and for a time led to a recurrence of the problems of retaining assistant staff.

When visits to the Forecast Room by airline personnel became less frequent during the late 1950s and 1960s, the direct involvement of assistants in civil aviation operations became less obvious, and to stimulate interest, guided tours of the Control Tower were arranged. During the 1960s, some of the forecasters agreed to give talks on various aspects of aviation meteorology for assistants who attended on a voluntary basis; as an added bonus for those who did so, arrangements were made with BEA for assistants to be given 'instructional' flights on Internal routes during the off-peak season, a practice which continued for many years.

Part II

Expansion of work and Move of Office

Initial reorganisation of upper air work to meet the needs of jet aircraft

As a preliminary step in preparation for the imminent introduction of jet aircraft, from October 1950 small European wind / temperature charts for the 300 mb level were plotted twice a day whenever possible, and from the following spring 300 and 200 mb European charts were plotted four times daily as a routine. Throughout the 1951-1952 BOAC Comet 1 proving flight period and indeed from May 1952 when passenger services started, streamlines were drawn on these charts and zone wind / temperature forecasts were prepared as needed by extrapolation. The flight frequency at that time was low and the normal stage length to Rome comparatively short, so it was deemed unnecessary to construct 200 mb forecast charts; when necessary, CFO forecast charts were used for guidance. One important point that did emerge was that there were many occasions when few if any 200 mb data were available along the route, and this caused problems with inbound as well as outbound services because in view of the pioneering nature of scheduled flights at this altitude, BOAC had insisted on full In-flight Meteorological Watch procedures for all Comet operations, including routine issue of QAOs. Strong representations were made through international channels about the paucity of 200 mb data over Europe and indeed over the whole of North America as well, and this approach bore fruit in time.

The suspension of Comet 1 operations following the metal fatigue tragedy gave Heathrow Met. a most useful respite from high-level operational flight forecasting and time to prepare for future services across the Atlantic. The small European charts

[2] This is a wry comment on 20th Century progress. The Meteorological Office in Victoria Street in 1902 had two Forecast Rooms which were used alternately so that thorough daily cleaning could be done without disturbing staff on duty. See Lempfert *Met Mag* **83** (1954). Sic transit ..... !

were replaced by the large 1:15 million charts covering Europe, the Atlantic and North America already in use for transatlantic forecasting, but the Upper Air Forecaster was too busy with operational output for 700 and 500 mb to do more than draw contour lines freehand, and could not attempt gridding.

In March 1954 BOAC started a one year paper planning exercise for the projected Comet 3 flights across the Atlantic, and with some misgivings Heathrow agreed to contribute to this by providing not only copies of the actual 200 mb charts but also forecast versions; these latter were perforce produced by extrapolation only, and due to shortage of time they were often dashed off in some haste, but it was recognised by all concerned that this was purely a paper exercise and in no sense an operational commitment. However, when the preliminary BOAC report on the exercise came to hand early in 1955, it revealed some disturbingly large forecast headwind component errors which were clearly operationally unacceptable. One of the Upper Air Forecasters was therefore taken off roster for a spell to conduct a thorough investigation. His report indicated that the primary cause of large errors was the freehand drawing and extrapolation processes used, that these were unsound, and that gridding was essential to ensure vertical consistency both at actual and forecast stages; a further suggestion was that some knowledge of tropopause topography would be extremely helpful. These recommendations were accepted by S.Met.O. and Met.O. 7, but could not be implemented until the staff position had improved. During the autumn of 1955, both BOAC and El Al started paper planning exercises for flights by Britannia 300 LR turbo-prop aircraft direct to New York, and asked for actual and forecast 300 mb charts. In the light of the Comet 3 exercise forecast-error investigation, forecast 300 mb charts could not be produced properly without gridding procedures, and the Upper Air Forecasters had no time to introduce these in addition to operational work at 700 and 500 mb; the airlines were therefore told that only copies of freehand drawn 300 mb charts could be provided and that they would have to omit checks on forecast accuracy. Britannia proving flights over Europe had started in September 1955 and with these and other turbo-prop aircraft like the Viscount coming into service the plotting routine had been extended to include wind / temperature charts at 400 mb; appropriate zone forecasts were then prepared by extrapolation, as they had been for the Comet 1 to Rome. The staff constraints at this time were severe, with the number of trained assistants more than 20% below established complement as well as the shortage of forecasters. As a straw clutching experiment, all contour heights were plotted as reported (i.e. in feet over North America and in metres over Europe) in order to save plotting time and hopefully to eliminate conversion errors; but not surprisingly this procedure proved so confusing that it was quickly abandoned.

As the time approached when paper exercises would be replaced by Britannia proving flights over the Atlantic, it was clear that gridding procedures would shortly become operationally essential for the 300 mb level, yet there was still no immediate prospect of staff increases on the upper-air bench. Fortunately in May 1956 the airlines made a small but useful concession. A large proportion of the scheduled transatlantic flights by piston-engine aircraft departed during the 1600 to 2200 time slot, and the operators had hitherto insisted on having preliminary versions of the relevant 700 and 500 mb forecast charts six hours before the operational issues so that they could make early plans for the evening rush. At the end of a long night duty, the Upper Air Forecaster therefore had to prepare not only the routine issues for departures between 1000 and 1600 but also preliminary charts for the evening services. This had always been an irritation, and as by this time transatlantic flight procedures were well established, the airlines agreed to drop this requirement. Most Britannias departed during the 1000 to 1600 period, so when proving flights started in August 1956 it was accepted that gridding could be introduced over a limited area on the 300 mb actual charts and that gridded forecast 300 mb charts would be prepared when necessary. From November 1956 these issues became a daily routine; but these were only makeshift arrangements and a major reorganisation of the upper-air work was urgently needed.

The inescapable task of establishing a subsidiary office in the centre of the airfield (see later) had absorbed all the limited staff resources of Heathrow Met. throughout

1955 and 1956, but during 1957 it at last became possible to expand the work on the upper-air bench and at the same time to co-ordinate more effectively the entire office output. The key to all this was the arrival of additional staff so that a second roster of Upper Air Forecasters could be employed on a 24-hour basis from 24 April 1957. After a short period of experiment, it was decided that the senior analyst would continue to draw the 500 mb charts; these were held to be of primary importance not only for flight planning but in connection with surface pressure pattern developments (Sutcliffe and Forsdyke 1950). He maintained a close liaison with the Senior Forecaster about that, and also drew the 300 mb charts by gridding from 500 mb using partial thicknesses. The 300 mb level was becoming of increasing importance as turbo-prop aircraft came into service, and by drawing the 300 mb charts himself the senior analyst could exercise a strong measure of control on the 200 mb charts which were gridded from them by the second analyst who also looked after the 700 mb level. The second analyst also constructed tropopause charts and transferred the 300 and 200 mb isopleths from them to the 200 mb contour charts to delineate areas where the 300 to 200 mb thickness pattern was wholly tropospheric, hybrid or wholly stratospheric.

Although in theory the Senior Forecaster was responsible for the entire operational output of Heathrow Met, in practice he had hitherto concentrated almost exclusively on Atlantic work, producing prebaratics covering only a limited area from the UK to the eastern seaboard of North America. But with an Atlantic Forecaster beside him to take care of documentation and briefing during busy periods, he had more time to devote to chart work, and it was decided his prebaratics should be considerably enlarged to cover most of the full 1:15 million chart area. With two Upper Air Forecasters, their output could also cover this extended area at all four standard levels, and these changes were important for two reasons. For the first time both Senior and Upper Air Forecasters became directly involved in forecast chart work covering Europe and the Western Mediterranean. Forecast positions of fronts and centres provided the Eumed Forecasters with a framework on which to construct their Significant Weather Charts which were introduced in May 1957 (see later), and although they continued to prepare zone winds for each flight they had the guidance of properly constructed forecast upper-air charts. Secondly, the westward extension of forecast upper-air charts over North America was timely because it was evident that the increased range of aircraft by then coming into service would soon lead to demands for flight forecasts to more distant destinations; indeed, in June 1957 a forecast was needed for a special flight direct to Vancouver and in September for one to San Francisco. From June 1957 onwards, fully gridded 300 and 200 mb forecast charts were issued twice daily as a routine, and the intermediate issues were also prepared when necessary for scheduled flights.

In September 1957, BOAC started Comet 2 services to Beirut; normal Eumed documentation was provided for these, including zone winds and temperatures, but the crews were also given copies of the latest actual 200 mb chart. That month, full services were also provided for an RAF Comet flight direct to Gander and for two special flights by TU 104 jet aircraft to New York via Keflavik. Aeroflot had been flying TU 104s for over a year between Moscow and London, but had never previously made Atlantic flights. An Air Attache from the USSR Embassy visited Heathrow Met. to discuss transatlantic documentation, crew briefing and flight watch procedures with all of which they were unfamiliar. He subsequently spent a great deal of time in the Forecast Room, talking to the forecasters involved and monitoring the progress of the aircraft in flight. Everyone concerned was well pleased with the meteorological service, and as a gesture of appreciation the two Atlantic Forecasters who had briefed the crews were invited, with their wives, to at tend a cocktail party at the USSR Embassy. In December 1957, both BOAC and El Al commenced passenger services to New York with Britannia aircraft, and BOAC Comet 4 services via Keflavik started the following May.

The gradual introduction of turbo-prop aircraft implied higher average ground speeds, and when the extended area forecast upper-air charts were started in April 1957, the opportunity was taken to increase the ground speed assumed in the composite chart process from 200 to 250 kts. By the autumn of 1958 transatlantic jet

services were also beginning and the operators were asked once more whether they wished to continue with composite charts. Whereas in 1955 opinion had been unanimously in favour, this trawl produced one dissenting voice; but as a clear majority still preferred them they continued, though with a further increase in the assumed ground speed to 300 kts in May 1959. By late 1960 a majority of transatlantic flights were being operated by jet aircraft so that the 200 mb level was becoming operationally far more important than the 500 mb level. It was therefore decided to re-arrange the work on the upper air bench so that the senior analyst became responsible for the 300 and 200 mb levels, also the tropopause charts, leaving his colleague to look after everything needed at 400 mbs and below; this took effect on 1 January 1961. From then on, the 300 mb charts were gridded directly from 1000 mbs, with contours drawn only at 400 ft intervals. It is believed that to reflect the large preponderance of jet services the average ground-speed assumption was again raised, this time to 400 kts. As ground speeds increase the need for composite charts diminishes, and the 400 kt figure implied a time difference of only six hours between the UK and the Canadian seaboard. Composite charts had almost outlived their usefulness, and in April 1962 they were finally laid to rest, having since 1948 played a most useful role throughout the development stage of transatlantic flights. They were replaced by 18 hour fixed time forecast charts. By the end of 1959, the upper-air plotting routine already included charts for 850, 700, 500, 400, 300 and 200 mb, also for the tropopause and maximum wind levels (see later), but in April 1960 yet another chart was added. One of the Senior Forecasters believed that 100 mb charts provided very useful guidance on general synoptic developments because they filtered out the transient features and reflected the long wave patterns. He had pursued this idea as a private project for some time, but C.Met.O. decided that it would be useful to add 100 mb charts to the plotting routine so that others could have an opportunity of assessing possible uses of these charts at Heathrow. The original work eventually led to a paper (Davis 1963) but the availability of these charts also stimulated a school of thought on the upper-air bench that, as the tropopause so often lies between the 300 and 200 mb levels, it might be better to construct the 200 mb chart by gridding down from 100 mb than by gridding up from 300 mb. After a trial period it was decided not to pursue this idea, but one interesting spin-off from the work was the discovery that the 200 to 100 mb thickness pattern provides a most useful guide to tropopause topography (Howkins 1962). The operational use of 100 mb charts for SST operations is discussed later.

The "Two Airport" Operation

It had been decided at a very early stage in the planning of Heathrow Airport that the permanent administrative, operational and passenger buildings would be located in the centre of the airfield with access by means of a tunnel underneath one of the main runways. This involved a vast amount of civil engineering and construction work which was expected to take some years; the move of operations from the Northside to the new Central Terminal Area (CTA) was therefore planned to occur in stages, and for a period (which in the event proved to be over seven years) there had to be what came to be known as the "Two Airport" operation. Preliminary thought was given to the implications of these plans for Heathrow Met. in 1951, and it soon became clear that two separate meteorological offices would be needed. The long-haul operators flying to North America, Africa, Asia and Australia who needed the most detailed meteorological advice for flight planning were scheduled as the last to move to the CTA so it was decided to leave the MMO on the Northside and to open a subsidiary office in the CTA to provide crew documentation and briefing there for the short and medium-haul operators. Good communications between the two offices were essential, and to gain experience in the use of facsimile an experimental circuit to Blackbushe was installed in January 1955.

By this time it was evident that no part of the permanent accommodation for Heathrow Met. in what was then known as the Eastern Apex Building would be ready when CTA operations began (shades of 1946!), so the Airport Authority offered, on a temporary basis, the use of a coach drivers' rest room in the Southeast Face Building which later became Terminal 2. Norris Marshall, who had worked on the

bench at Heathrow for some years, was brought back from ATCC Uxbridge to act as officer-in-charge and the CTA meteorological office opened for business on 16 April 1955, the first of the Airport operational sections to do so. As such, it attracted a great deal of attention, even in its temporary home, and had many distinguished visitors including Lord Brabazon, Lord Douglas and Peter Masefield. Full 24-hour cover was maintained in the CTA office from the outset, with watches of three assistants and, except during the evening lull, three forecasters at all times. Five teleprinter channels were installed to provide basic and OPMET data, together with two facsimile circuits from the Northside MMO to bring advisory and flight forecast material, but the CTA forecasters did have their own plotted charts covering Europe and the Mediterranean. With the aid of a Banda duplicator, documentation was assembled for all CTA departures and all crews were briefed personally. This was no small commitment because during the first full month of operations there were over 3000 scheduled departures from the CTA compared with slightly fewer than 2000 that month from the Northside; three years later in July 1958 over 5000 flight forecasts were issued by the CTA office and in July 1960 around 6000, roughly twice as many that month as at the Northside MMO.

Despite the very cramped quarters in the temporary office, extremely good relations were established with Airport and airline staff and especially with the aircrews, many of whom took the trouble to call after arrival on inbound services to tell the forecasters what weather and winds they had encountered; BEA crews were outstanding in this respect. When Aeroflot started operations to Moscow, the CTA officer-in-charge and S.Met.O. were given a conducted tour of a TU 104 aircraft on the tarmac. The high standing of Heathrow Met. was also recognised when HM The Queen officially opened the new CTA on 16 December 1955; the S.Met.O. and his wife were formally presented to her and, as one of the official ushers, the CTA officer-in-charge joined the official party for tea. To mark the occasion, the Eastern Apex Building was renamed as the Queens Building. On 21 April 1956 the CTA office moved into part of the permanent Heathrow Met. accommodation in the Queens Building. With ample space in which to work, both forecaster and assistant watches were increased from three to four and as the extra forecaster was of SXO grade, from then on the ties with the MMO were loosened and flight forecasts were prepared independently. To provide a broader basis of information for all this, eight instead of five teleprinter channels were installed. Work to provide all the furnishing and equipment needed for the MMO continued for more than four years while the CTA office alone occupied the premises. Crew briefing in the Forecast Room continued as the norm, but useful experience of the new Briefing Bays was gained during public holiday rush periods.

On 7 December 1960, MMO Heathrow moved from the Northside to the Queens Building office (see later). Unfortunately this did not mark the end of the "Two Airport" operation because pending completion of the CTA long-haul passenger building (Terminal 3), all the airlines scheduled to use it were still based on the Northside; it was therefore necessary to apply the 1955-1960 procedures in reverse, with the MMO in the CTA supplying flight forecast material to a Northside documentation and briefing unit maintained in the old office. This unwelcome arrangement should have ended when Terminal 3 opened, but several airlines including BOAC, PAA, El Al and Air India did not for some time move to it.

They were however persuaded to accept the closure of the briefing office on 7 June 1962 and until November 1963 when PAA at last moved, documentation was sent across by dispatch rider; there was an option of telephonic briefings on request, but this procedural change was significant for Heathrow in that it marked a break in the long tradition of personal briefing for all flights.

Significant Weather Charts

The production of pictorial cross-sections or tabular forecasts for each and every flight is very labour intensive, and by the mid-1950s the rapid increase in air traffic was making the logistics of this task quite formidable at busy airports like Heathrow. Aircraft which fly at low altitude, often with a minimum of navigational equipment

(e.g. Flying Clubs and a good deal of General Aviation) clearly need detailed information of this kind about en-route weather, but once the post-war civil aviation procedures had settled down and more modern aircraft operating at higher altitudes had come into service, the airlines did not. For most scheduled services therefore, the traditional documentation seemed unnecessary and the fact that it applied only to a specified track and departure time meant that it always had to be reviewed if a flight was delayed or its track changed before take-off; from the airline point of view it had a further disadvantage in that when aircraft had to be diverted in flight, relevant weather information was not available on the flight deck and had to be sought by radio from a Control Centre.

In discussion of these problems at an ICAO meeting in 1954, the United States suggested a new form of documentation to be known as a Significant Weather Chart which depicted only weather of direct operational concern to aircraft, such as severe turbulence. Each chart would cover a largeregion and areas where there was no significant weather would be left blank. The USA proposal was that traditional documentation should be retained for aircraft flying only below 5000 ft, but that the new form should be issued to all aircraft operating at 5000 ft and above within the region during a specified period of validity. This was such an attractive idea that definitions and procedures were quickly formulated in detail and internationally adopted. From the meteorologist's point of view the new system concentrated on essentials and offered obvious advantages in staff saving and the elimination of needless work; but the concept also appealed to many airlines because it implied that relevant information would always be on hand to cover enforced departures from flight plan either before take-off or in the air.

Subject to Air Traffic Control (ATC) constraints to ensure adequate separation, the Atlantic operators at Heathrow had freedom over track selection, and for various reasons take-off delays and late changes of track were far from unknown. The advantages of Significant Weather Charts were therefore immediately apparent to them and they agreed to accept the new documentation from May 1956; their aircrews had found cross-sections of little use on the long oceanic legs and also generally welcomed the change, as did the Atlantic Forecasters who had to prepare one chart instead of perhaps eight or ten different cross-sections.

European operators normally fly much shorter stages and on fixed airways or advisory routes, so that the advantages for them were less obvious. A much longer period of discussion was therefore required before agreement was reached, and the Significant Weather Charts were not introduced until May 1957. By then individual documentation was being prepared for an average of over 130 flights a day from the CTA alone and over 200 a day at weekends, so, not surprisingly, the forecasters welcomed the change with open arms. The Significant Weather Charts were prepared by the Eumed Forecasters, using the positions of fronts and pressure centres on the extended area prebaratic which the Senior Forecasters had started the previous month.

Whereas the Atlantic crews had with few exceptions been entirely happy with Significant Weather Charts, European crews were not and their objections were undoubtedly amplified by the manner in which the change was introduced. To save time, the Eumed Forecaster traced the frontal framework from the Senior Forecaster's prebaratic directly onto a 1:15 million European chart on which he then depicted the significant weather. Aircrew on short-haul services to Brussels or Paris for example, were thus presented with a large piece of paper on which their routes were barely 2 cm long, and not surprisingly felt that their particular concerns had received scant personal attention compared with that given to the tailored cross-sections. To smooth out some of the ruffled feathers, cross-sections along the main European airways were prepared regularly as briefing aids and further changes were made to the documentation. From November 1957, European Significant Weather Charts were prepared and issued on a scale of 1:7·5 million, and revised versions were produced every three, instead of every six hours. These measures helped to allay most of the initial misgivings and the documentation came to be accepted, albeit not unreservedly; 6-hourly issues were not reintroduced until November 1966.

For three years after 1957, cross-sections were still prepared for the small number of medium-haul flights (e.g. to the Middle East) which went beyond the European Significant Weather Chart area. As a staff economy measure, from June 1960 these flights were given the hybrid and untidy documentation of a Significant Weather Chart covering the first part of the route and a cross-section for the remaining part; but by December 1961 the number of these flights had increased sufficiently to make it worth while to prepare a second Significant Weather Chart covering the Eastern Mediterranean and the Middle East. Cross-sections then disappeared from the Heathrow Met. output until, interestingly, they were re-introduced in 1969 when Concorde started flying (see later).As jet aircraft came more and more widely into service, it was decided that a great deal of irrelevant information could be eliminated from the Significant Weather Charts if they depicted only significant weather above 20,000 rather than 5000 ft. In 1976 yet another very-high-level Significant Weather Chart was introduced specially for Concorde.

Isotach and Spot Wind Charts

The introduction of Significant Weather Charts did nothing to ease the considerable burden of preparing zone winds for every individual flight. This commitment was especially exacting for transatlantic services which required data for three levels in each of 12 to 15 zones along every track selected; if a flight plan was changed before take-off, all the work had to be done again. Another occasional problem was that when analysing contour charts to select optimum tracks, inexperienced flight dispatchers sometimes made insufficient allowance for ageostrophic effects, especially those due to trajectory curvature round the northern flank of eastward moving upper lows and in strong anticyclonic zonal flow; final flight plans calculated from the zone winds might then prove to be impracticable, necessitating revised track selection, new zone winds, a new flight plan and often a departure delay while all this was sorted out. It is difficult in retrospect to understand why the obvious way round these problems did not emerge sooner. The use of isotachs on upper-air charts had been considered at Heathrow as early as 1951, and by 1956 some Upper Air Forecasters used them regularly as a valuable discipline in chart construction and to make the extraction of zone winds for a number of different tracks a much quicker process; it was not necessary to draw isotherms as well because the temperature field could be indicated quite adequately by a judicious scattering of spot values. After some discussion, all the Atlantic operators agreed that 850 mb data were no longer needed and that isotached contour charts for 700 and 500 mbs with spot temperatures would be acceptable, indeed welcome for flight planning and documentation; these were therefore introduced on 1 June 1957, ending the provision of zone winds and temperatures for Atlantic flights. As with Significant Weather Charts, the needs of Eumed operators were not the same as for the Atlantic services, and it was generally agreed within Heathrow Met. that isotach charts would be inappropriate for these shorter routes on fixed tracks. Zone winds had always been prepared by the Eumed rather than the Upper Air forecasters but by 1959 with an average of over 200 Eumed departures a day during the summer peak, they were finding it impossible to give adequate attention to this task. A third roster of Upper Air Forecasters was therefore introduced, at XO level, to prepare all zone winds and temperatures required for Eumed services, and during spare moments to assist the senior analysts with the experimental work on the tropopause and maximum wind levels (see later). However as the number of daily departures continued to grow, it became clear that some form of 'universal' rather than 'individual' documentation was essential; this took the form of a Spot Wind Chart which came into use in October 1962 and was generally welcomed. Special background charts were developed, with sets of boxes printed at appropriate intervals along all the main air routes ex Heathrow; winds and temperatures for four or more levels between 5000 and 30,000 ft were then inserted in these boxes. Spot Wind Charts were prepared every three hours for issue in association with the European Significant Weather Chart, and as with those, a second South-eastern Europe version was later added, finally eliminating zone winds and temperatures for individual flights.

The Tropopause and Maximum Wind Levels

Wind and temperature data supplied for transatlantic operations referred to standard pressure levels, and values needed for intermediate altitudes were obtained by simple interpolation. This practice is quite acceptable within the troposphere, but cannot be applied between pressure surfaces which bracket either the tropopause or level of maximum wind (LMW). The imminent introduction of jet aircraft like the Comet 4 and Boeing 707 therefore led to much thought at Heathrow Met. and at other national forecast centres with a responsibility for oceanic flights. The performance of jet engines is far more dependent on ambient temperature than is that of piston engines, and the ICAO Jet Operations Requirements Panel laid down a need for temperature forecasts within plus or minus 3C; the operational need for tropopause charts was thus self-evident. These had been drawn since the spring of 1957 as an aid to analysis at the 200 mb level, and it had been found that the tropopause heights reported in accordance with strict criteria in the radio-sonde messages did not always fit readily into coherent patterns. However, by extracting heights ab initio from the plotted temperature profiles using locally developed rules, consistent analysis did emerge; this practice necessitated a great deal of tephigram plotting and analysis, in which the Atlantic Forecaster helped, but was found to be well worth while. Once experience had been gained of the evolution and development of actual tropopause topography, experimental forecast versions were prepared, and from June 1960 these were issued twice daily as a routine for planning and documentation; this procedure seemed to meet the operational requirement for temperature prediction, linear interpolations being applied as needed between the temperatures on the tropopause charts and those on the standard pressure-level charts.

Dealing with jet-stream winds was much more difficult as there was no background of experience or knowledge about LMW patterns and how they behaved. The potential importance of jet core winds was dramatically emphasised by an incident when an aircraft flight planned near the 200 mb level was instructed by Canadian Oceanic Control to descend 4000 ft or so at 30^{o} W because of a military aviation exercise; the headwind component then experienced was far in excess of winds at both 200 and 300 mbs and if diversion from Gander had been necessary there would have been serious trouble. A most interesting idea from the United States (Harmantas and Simplicio 1958) proposed the use of Tropopause Vertical Wind Shear (TVWS) charts. It was suggested that the wind at any level between 300 and 200 mbs could be indicated by the charts for those levels, together with a chart of mean vertical isoshears in knots per 1000 ft which would apply up or down to the LMW: most importantly it was then assumed that for practical purposes the LMW could be taken as being at the tropopause. Although the concept of TVWS charts was welcomed by PAA in particular, general opinion on the upper-air bench at Heathrow was that the procedure was flawed, because the basic assumption that the LMW coincided with the tropopause was neither justified by theory nor borne out by observations. In view of the international importance of developing sound procedures for the provision of information to jet aircraft, the WMO Commission for Aeronautical Meteorology (CAeM) had set up a panel of experts to consider the subject, and one of the Heathrow Upper Air Forecasters was nominated as UK member for the second meeting of this panel at Brussels in March 1959. Here it emerged that Heathrow opinion about TVWS charts was also that of Orly Met., who had noted that the LMW could, in extreme cases, be as much as 5 kms above or below the tropopause! The immediate outcome of the Brussels panel was that at the ICAO Met. Division meeting in Montreal later that year, despite the hopes of the USA, TVWS charts were not endorsed as an internationally recommended practice. A comprehensive description of the high level analysis and prognosis techniques which had been developed by twelve WMO Members was published (WMO Tech Note 35, TP 45, 1961); this stands as a valuable record of the state of the art world-wide in 1960 and the UK contribution describes work at Heathrow.

LMW charts were plotted from April 1959, but early attempts at analysis were not very successful; isotachs of maximum speed appeared to form coherent patterns,

but LMW isopleths did not. In the light of the earlier experience with tropopause charts it was regretfully decided that vertical profiles of wind as well as temperature would have to be plotted, and this was done from June 1960. This was a major addition to the already heavy upper-air plotting routine, and as a partial offset 700 mb chart work (by this time of diminishing operational importance) was simplified. It was soon found that many vertical wind profiles were quite flat, so three heights were plotted on the charts, namely the reported LMW and also the levels above and below this where the wind speed was 10 knots less than the maximum value; these latter heights were then regarded as limits between which LMW isopleths could be drawn in a manner that maintained pattern continuity. Work on these lines with LMW charts continued for well over a year and with some success, but it was then decided to concentrate effort on the operationally significant regions near jet cores. As an experiment the predicted positions of jet cores, with speeds and heights indicated at intervals along them, were marked boldly on the 300 mb forecast charts; this practice seemed to find favour both within the office and with the airlines, and by general agreement with the operators was introduced in February 1962 onto all chart issues for planning and documentation.

Maximum wind information was again discussed at an ICAO MET/OPS Division Meeting in 1964; TVWS charts were then, as the USA wished, formally recognised as an approved form of documentation, but so too were Tropopause / Maximum Wind (TMW) charts which carried tropopause height contours and spot temperatures, also positions of jet cores with heights and maximum speeds marked at intervals along them. This latter procedure was closely akin to that introduced at Heathrow two years previously, so no real change was needed at Heathrow. However, under the prospective ICAO Area Forecast System (see later), Heathrow Met. was hoping to become the major civil aviation forecasting centre for westbound flights across the Atlantic from any part of Europe, and as some airlines, notably PAA, seemed to be hooked on TVWS charts, Met.O. 7 decided that it would be politic for Heathrow to introduce them and this was done in May 1965. By the end of 1965, numerically produced charts were beginning to arrive at Heathrow on line from CFO Bracknell (see later) and the airlines were asked if they would accept contour charts for 300, 250 and 200 mbs in lieu of 300 mb and TVWS charts; after prolonged discussion, although most agreed to this, some airlines still insisted that TVWS charts were essential. As an added incentive from January 1967, 250 mb charts were issued as well as the TVWS charts, and at the end of December 1967, no doubt with great relief, the preparation of actual and forecast isoshear charts ceased. It was then agreed by all concerned that 300 and 250 mb charts, together with TMW charts would suffice for transatlantic planning and documentation; 200 mb forecast charts also ceased at this time, making a significant reduction in the overall output required from the upper-air bench.

Extra-roster Staff Activities

As indicated in the earlier section on manning problems, one significant factor contributing to the excessive overtime working at Heathrow by forecasting grades in particular was the amount of time necessarily spent on official activities over and above those needed on the bench to produce the daily operational output. To an extent, work of this kind has to be done at all forecasting offices, but the position of Heathrow Met. at the centre of the great post-war expansion of meteorological services for civil aviation was unique, and the quantity of extra work far greater than normal. New ideas and techniques developed and tested at Heathrow and the wealth of information assembled there were of much more than purely local significance and often formed the basis of national views put forward at international meetings, or subsequently led to procedures introduced throughout the UK. All this was in no way resented by the staff; it was in general welcomed as adding interest and diversity to the job. But there was certainly a feeling locally that the contribution being made to the common weal was not given the recognition it deserved when established complements were fixed. The first group of these extra-roster activities may be described as technical administration which in theory might have been done by the staff appointed for that purpose. But there were too few of them during the first 15 to

20 years at Heathrow to deal with everything and roster staff had to assist; a full time Deputy post was not established until December 1957. As the number of departures steadily increased, exceeding 10,000 in peak months by the early 1960s, the preparation of daily work schedules for each forecaster post became a major and very intricate task. One of the bench forecasters became an expert in this field and, until a computer programme was developed in 1967 to do this task, he had to be relieved of roster work for a few days each month to cull the necessary data from various Airport and airline sources and to keep the information up to date. An associated chore was that of finding out from each airline which alternates they used and then making sure that all the necessary TAFs were available; before the advent of MOTNE in 1960 this often involved signalling meteorological services overseas to arrange for AFTN messages to be sent regularly. Other forecasting offices needing overseas TAFs could and did often obtain them from Heathrow Met. A third task which occupied a great deal of time for over 20 years was the preparation of monthly returns for Met.O. 7 in connection with the scheme for DG Met.O. awards to Captains and Navigators; from log books kept on the forecast benches, flight watch messages and other sources individual records had to be compiled for every Captain and Navigator in the national airlines, showing the contributions made by radio or after landing. Fourthly, there was the need to respond to all the enquiries made by BOAC and BEA whose national centres were based at Heathrow. Hardly a month went by without two or three requests for weather information about some location in the UK or abroad where there had been an incident affecting a company aircraft or freight, or calling for comment on some alleged en-route forecast errors; many of these latter proved unfounded, but studying all the relevant charts and writing a report took time. Familiarisation flights were a second major reason for absence from the bench. All aviation forecasters are rightly encouraged by the Office and by ICAO to improve their understanding of the job by gaining flying experience. As soon as things had settled down after the War, the national airlines willingly agreed to carry forecasters on familiarisation flights from their home airports and provided them with flight deck passes. Forecasters normally fly only on routes for which they regularly provide documentation and briefing, and have to write post-flight reports on what they learnt both in the air and through the contacts they are expected to make on the ground with meteorological offices at the destination airfields. The number of these flights is strictly limited and prior approval has naturally to be obtained both from the airline and from the Met.Office; they are made entirely on a voluntary basis. As soon as the procedures had been formalised during the mid-1950s, some of the Eumed Forecasters took the opportunity to participate; post-flight reports were circulated both at Heathrow and more widely within Met.O. 7, and brought to light a great deal of interesting and useful information. Due to hard currency shortage, the Treasury would not agree to flights across the Atlantic until 1960, but Senior and Upper Air Forecasters were then able to fly and no fewer than five did so in April of that year. As aircraft flying longer stage lengths came into service, forecasters were able to go farther afield, in 1969 to Bermuda, Barbados and Anchorage for example and in 1976 to Miami, Los Angeles and Nairobi. Inevitably, flights of this kind prolonged the period of absence from the roster, and it was sometimes also agreed that a forecaster should spend a few days at a meteorological office abroad; stays of that type were made at New York, Washington and Copenhagen. A third category of official work involving absence from the bench was the detachment of staff for duty elsewhere. Staff at Heathrow acquired a great deal of specialist knowledge, and calls were made from time to time on this reservoir of experience. The temporary postings of assistants familiar with Atlantic and North American data to CFO in 1949 were cases in point, and similar detachments were twice made to Aldergrove when an Atlantic forecasting unit was temporarily set up there to brief special RAF flights to Canada. Detachments were also necessary to cover leave at the Heathrow outstations and to bolster local staff when due to prolonged fog at Heathrow in 1952 and 1962 many aircraft were diverted to, and subsequently operated from Hurn. Heathrow forecasters were also sometimes required to attend WMO and ICAO meetings as UK representatives, and taking into account the preliminary briefing meetings and preparation of material, also the need to write full reports subsequently

for Met.Office HQ, these commitments not infrequently implied absences of several weeks.

Perhaps the greatest bone of contention between Heathrow Met. and those who fixed established staff complements was the feeling that the unique contribution made on the upper-air bench was under appreciated. In trying to meet all the airline requirements for jet aircraft, staff were faced with problems to which textbooks, the Training School and the Research Branches offered no solutions. As described earlier, technically sound methods had to be established for the construction of forecast 200 mb charts across the Atlantic and North America, and more importantly there was a need for detailed information about the tropopause and LMW. A case was submitted to Met.O. 7 for the addition of two SSO / SXO posts to the team of senior upper-air analysts to provide an operational research and development capability; at any given time, two of the Upper Air Forecasters could be given a spell off the bench to develop new ideas before returning to the roster to try them out under time pressures of daily operations. Unfortunately this scheme did not find favour, but the work had to be done nevertheless, and overtime was the result.

Arising from work of this kind and other personal interests, individual staff members produced a number of papers on specific meteorological topics. Much of this work was done in off-duty time, but those working on approved projects of direct local concern were whenever possible given official time off roster. Some of this material was circulated internally and this practice was formalised in 1967 by the commencement of a series of Technical Notes; many papers of wider interest were however published (e.g. Davis 1951, Turner 1959, Howkins 1962, Wiggett 1964, Atkins 1965, Binding 1965, Lennie 1969).

The Queens Building Office

This was the first permanent home for Heathrow Met. and was occupied for over 20 years. The space allocation of over 9000 sq ft was generous and the opportunity of designing a layout and specifying office equipment ab initio should have led to a happy and efficient working environment. It was indeed initially a big improvement on the Northside Office, but this state of affairs did not last. When planning took place, during the 1950s, no one could have foreseen the rapid changes that would occur in the meteorological requirements of the airlines, in telecommunications and in computer technology; still less did anyone visualise the CTA developments that transformed the office environment for the worse in 1966. One new feature successfully incorporated in the new office was the provision of separate Briefing Bays. Personal meteorological briefing was then the norm for all flights, and as a considerable increase was correctly expected, no fewer than five Bays were built, together with a large adjoining foyer of over 800 sq ft in which crews could assemble. When briefing outside the Forecast Room had been tried during the early days of the Northside Office, it had been found unacceptable largely because of the difficulty of obtaining copies of all the necessary charts and up-to-date meteorological data for use outside the Forecast Room. To avoid this problem, the Bays themselves were equipped with teleprinter tails and efficient chart copying equipment was specified as essential.

These new arrangements worked quite well and were accepted by the aircrews with few objections. Bays were manned continuously during busy periods, but at times some of them were left vacant, with a bell to summon a forecaster from the Forecast Room. Admittedly the Bay Forecasters did develop a mild feeling of isolation, but that was lessened by the introduction in March 1961 of an intercom system linking them with the Forecast Room. A new procedure was also introduced in May 1961 whereby the Eumed Forecaster briefed all the Bay Forecasters every three hours when he produced a new Significant Weather Chart. Some minor structural alterations made in 1962 also helped; the partition walls between Bays were reduced in height to permit visual and verbal contact between forecasters working in them and also to give greater flexibility when someone was temporarily absent, for example having a meal break. As some of the major airlines did not move to the CTA until some years after Heathrow Met. did so, it was rarely if ever necessary to use all

five Bays simultaneously. By 1962 it was decided that three Bays would suffice for briefing purposes and that it would be to everyone's advantage if the important and growing task of TAF sheet preparation for documentation was concentrated into a small unit dedicated to this task. The two adjoining Bays on the far side of the Briefing Foyer were therefore converted into what became known as the TAF Bay, equipped with its own teleprinter tails to provide the necessary OPMET data, and linked with the intercom system. The Forecast Room was very large (over 2500 sq ft) and it was realised that the distribution of teleprinter data to plotters would involve a considerable amount of walking about with pieces of paper. A 'mechanical finger' message conveyor system as used in certain large newspaper offices was therefore requested; this could in theory deliver pieces of paper from the Teleprinter Room to any one of three baskets strategically placed beside benches in the Forecast Room. This was duly installed, but proved a great disappointment, being both inefficient and unreliable; by late 1962 the system was deemed hopeless and it was subsequently dismantled. After many delays, work started in March 1965 to install a new 'drag band' conveyor system, but this too failed to live up to expectations and within 18 months had been declared useless; it was finally removed in April 1967. Most staff greatly preferred the exercise, personal involvement and above all reliability of hand delivery and this continued to be used until 1980 when the Transtel teleprinters arrived (see later).

Also part of the original Heathrow Met. suite in the Queens Building were two Teleprinter Rooms, a Duplicating / Facsimile Room, two Forecasters' Workrooms, a Library, a Statistics Office, two Staff Rooms, a small Pantry, three offices for C.Met.O. and his staff and four Store Rooms. The first major re-arrangement was initiated in 1964 when Heathrow Met. was moving towards new responsibilities both as Principal Forecasting Office (PFO) for civil aviation in the UK and as an Area Forecast Centre (AFC) under ICAO (see later). These new duties implied much greater use of facsimile, for transmission as well as reception; there was also by this time a growing requirement for documentation and briefing material, and the Duplicating / Facsimile Room was becoming extremely cramped. Plans were made to convert one of the Teleprinter Rooms and the Pantry into a new Facsimile Room, leaving the existing shared room for Documentation and Duplication only; MOTNE circuits having been installed in the TAF Bay, only one Teleprinter Room was needed and space was found for a new Pantry near the Staff Rooms. Work started on this conversion during the spring of 1965 and was completed in April 1966; further enlargement of the Facsimile Room was needed in 1969.

With all its disadvantages, the large Northside Forecast Room had at least provided an excellent view across the airfield, plenty of light and windows that could be opened to provide fresh air. By contrast, most of the Queens Building rooms were internal, necessitating constant artificial light and forced ventilation; there were however windows along one wall of the Forecast Room and C Met.O.'s offices giving a view south-eastwards across part of the airfield. In 1964 the Airport Authority announced plans for new apron development that were to have disastrous consequences for Heathrow Met.

The first impact of this development was the construction during the spring of 1966 of a covered ramp, sloping down across and not far from the office windows, to give passenger access directly from Terminal 2 to the new apron. This was bad enough, blotting out the view from all but one of the windows, but the situation became far worse during the autumn when the apron was brought into use; aircraft being run up there produced quite unacceptable levels of kerosene fumes so that the windows could never be opened, and even with them shut the noise was too high. Needless to say strong representations were made about this to BAA who had by then taken over the management of Heathrow. Some minor modifications were made to the ramp but a request for the installation of air conditioning was flatly refused. The battle continued throughout 1967 but with no more success than a re-positioning of the ventilation intake which brought some improvement but by no means solved the problem. Indeed, it was noted in summer that the temperature at night in the TAF bay was 80º F with the ventilation inflow temperature higher than this!

Matters appeared to have reached an impasse and early in 1968 Heathrow Met. submitted a formal application to be re-housed elsewhere. Up to this point, BOT had taken the not unreasonable view that as the problem stemmed from airport development it was up to BAA to solve it; but they had not done so and Heathrow Met. staff were having to work in an extremely sub-standard environment. BOT therefore decided that they might possibly be able to pay for the necessary work themselves, and in March 1968 asked BAA to prepare plans for full air conditioning and to let them have the estimate of cost. This was not produced until nearly two years later in 1970 and unfortunately the estimate was so high that BOT Finance Department was unable to find the necessary funds for the work to be done.

As if to rub salt into the wound, during a hot spell in the summer of 1970, BAA positioned a mobile generator just outside the Forecast Room near the ventilation intake, causing pollution, heat and noise to reach even higher and quite intolerable levels; despite the most vehement protests, this generator was kept in use where it was throughout a period of planned maintenance work. Not surprisingly, it became increasingly difficult to retain Assistant staff at Heathrow when they had to work under conditions like that. Minor palliatives like a re-arrangement of benches in the Forecast Room in 1969 to position the Local Forecaster beside the only window from which there was still a limited view of the airfield, or the complete redecoration of the office in 1972 did nothing to solve the basic problem, and the announcement in late 1975 of the possibility of a move to the Control Tower Building must have come as a relief. Working conditions were described as 'insufferable' during the heat wave of 1976.

Apart from the major refurbishment needed in 1980 to house the computer system (see later), the final re-arrangement of the Queens Building accommodation took place in 1976, primarily to make space available for two very welcome lodger units. Following the installation during the late 1960s of all the facsimile equipment needed to support Heathrow Met's new roles as Principal Forecasting Office (PFO) and Area Forecast Centre (AFC) (see later) Met.Office HQ decided that it would be convenient for all concerned to base an Area Maintenance Unit at Heathrow so that a technician would normally be on the spot when needed. One of the Forecasters' Work Rooms was re-allocated for this purpose, but by 1976 was proving too small. The other unit needing space in the Queens Building was the Civil Aviation Communications Centre (CACC) which was based in the Control Tower Building. When the Queens Building opened, it was linked to the Tower with a Lamson pneumatic tube installation, by means of which Met. and the Air Information Service (AIS) could exchange messages with ATC, also both send and receive AFTN signals. Even by 1964 this system was giving trouble, and although it was kept running for more than 10 years CAA decided that instead of renovating this out of date technology it would be better to locate a small sub-centre of CACC in the Queens Building so that it could handle on the spot all the traffic that had previously passed through the pneumatic tubes; it would also then be easy to arrange direct VDU access to the CACC data bank of OPMET data. By 1976, the extension of self-briefing (see later) had made one of the Briefing Bays surplus to requirements and this was re-equipped as the TAF Bay. The Area Maintenance Unit then took over the larger space vacated by the TAF Bay; this released a room for CACC, conveniently leading off the Briefing Foyer so that both Met. and AIS had ready access to it.

Part III

The Impact of Improved Telecommunications, Automation and the Philosophy of Self-help

Principal Forecasting Office for Civil Aviation in the UK

The rapid post-war expansion of civil air traffic in the UK had been centred at Heathrow, and over a period of 15 years up to the early 1960s a very large forecasting organization had been developed there to meet the growing

requirements for long-haul jet aircraft. By this time, more aircraft of this type were coming off the production lines and it was evident that similar meteorological services would shortly be needed at airports such as Gatwick and Ringway where the forecasting offices could not provide them from their own limited resources. It would have been grossly uneconomic to expand other offices into replicas of Heathrow Met., and indeed the need to maintain an independent transatlantic forecasting organization at Prestwick was not clear cut despite the commitment there not only for flight forecasting but also for the Oceanic Control Centre. A separate difficulty had arisen over the provision of guidance and flight-forecast material to increasingly busy airports such as Southend and Luton where there was no meteorological office at all. Fortunately, the availability of land line facsimile offered a solution to these problems.

On specific occasions during the summer of 1963 arrangements were made with the Meteorological Communications Centre (MCC) at Bracknell to relay transatlantic forecast material to Manchester and Belfast Airports and to RAF Lyneham using circuits that were part of the national facsimile broadcast network (MOLFAX), but clearly this sort of thing could not be done on a regular basis. During the autumn of 1963 therefore, dedicated facsimile circuits were installed from Heathrow Met. to forecast offices at Gatwick, Prestwick and Manchester who might increasingly be asked to provide flight forecasts for the Atlantic and long Eumed routes. In 1964, plans were developed to broaden these arrangements into a new facsimile broadcast to be known as the Civil Aviation Meteorological Facsimile (CAMFAX) which would provide a full range of advisory flight forecast material. After extended trials and financial approval by MOA, connections to CAMFAX were gradually extended not only to civil aviation forecast offices but also to busy non-state airfields like Southend and Luton. This put Heathrow Met. in a position where, to an increasing extent, it was providing flight-forecast material to other airfields, and in October 1965 Met.O. 7 decided to formalise these arrangements by making CAMFAX material the basis of documentation for civil flights at 5000 ft and above from all UK airfields. The CAMFAX broadcast was officially inaugurated in May 1966 and Heathrow Met. then became the PFO for all civil aviation in the UK.

Responsibilities for Air Traffic Control Centres

An Oceanic Area Control Centre (OACC) is responsible for maintaining an organised track structure over its area, with safe air traffic separation, also for providing an information service for aircraft in flight (CAA 1985). For many years aircraft overflying the NE Atlantic east of 30º W were looked after by either OACC Shannon or OACC Prestwick, the latter naturally obtaining its meteorological service from Prestwick Met. But by the mid-1960s, Heathrow Met. had become the major transatlantic forecasting office in the UK, and with the aid of the new facsimile circuits was supplying Prestwick Met. with Atlantic flight forecast material including Significant Weather and upper-air Charts.Met.O. 7 therefore decided that Heathrow Met. should become directly responsible for meteorological services to OACC Prestwick and this took effect on 1 November 1965. Shortly afterwards, OACC Prestwick took over the Shannon control area and on 13 January 1966 Heathrow Met. thus assumed responsibility for the whole of what became known as the Shanwick oceanic area.

The MMOs responsible for Air Traffic Control Centres (ATCCs) provide them with meteorological information of two kinds. The controllers need general area forecasts including detailed information on upper winds at all levels, especially at the OACCs where safe track structures have to be established. OACC Prestwick therefore started using Heathrow upper-air charts for this purpose and by 1969 grid-point data from the numerical prediction model being run on the computer at Bracknell (see later) were also fed directly into the Apollo computer at OACC. In due course, the upper wind requirement was met by grid-point data alone. Secondly, warnings of weather such as severe turbulence which might cause problems for aircraft in flight are issued whenever necessary as SIGMET messages. Aircraft in flight within a control area known as its Flight Information Region (FIR), can also obtain information including meteorological data or advice by request from the ATCC.

The ATCC, which had been at Uxbridge for many years, was re-located at West Drayton and not long afterwards the Met.Office decided to close the responsible MMO and to transfer all its forecasting work to Heathrow. From April 1973 therefore, Heathrow Met. became responsible for general and upper wind forecasts to ATCC West Drayton and for the issue of SIGMETs for the London FIR. A year later, West Drayton took over the upper airspace (above 24,500 ft) in the ATCC Preston area and in January 1975 ATCC Preston was closed and the London FIR was extended to all controlled airspace over England and Wales. The Heathrow Met. commitment was widened to take account of these changes. A second consequence of taking over the West Drayton work was that Heathrow Met. also became the only civil aviation MMO for Southeast England, a role which became increasingly important, especially in the 1980s (see later).

As a safeguard for Royal and VIP helicopter flights, the appropriate ATCC is provided with forecasts covering notified routes. MMO Upavon had been responsible for the issue of these forecasts within the London FIR, but at the beginning of 1976 this commitment was transferred to Heathrow where, except for one brief period, it remained until 1985. At times this could be a significant addition to the normal workload; in June 1976 for example, Heathrow Met. had to prepare no fewer than 32 of these special safeguard forecasts, in addition to 45 route forecasts for Royal and VIP fixed-wing flights originating at Heathrow.

With the establishment of the new ICAO RAFC at Bracknell rather than Heathrow (see later), the responsibility for issuing SIGMETs for the Shanwick and London FIRs passed to CFO in March 1984. By then the need for upper-wind information at OACC Prestwick had long been satisfied by the routine transfer of grid-point data from Bracknell to their Apollo computer, but Heathrow Met. continued to supply area forecasts and manually produced upper winds for the London FIR to ATCC West Drayton every four hours. During the first six months of 1985, comparisons were made between these manually prepared data and those that could be produced by the computer at Heathrow (see later), and from the end of July the computer versions were substituted. The area forecasts were stopped at the same time, marking the end of an involvement with ATCCs that had lasted for almost 20 years.

The Introduction of Numerical Forecasting at Heathrow

A great deal of development work on numerical prediction took place in the Met. Office during the early 1960s. By contrast with the traditional gridding techniques whereby upper-air charts are derived products based on surface (1000 mb) predictions, the three-level model then used produced forecast contour charts for 500 and 200 mb as direct output; charts for the 700, 300 and 250 mb levels and temperatures for all levels were obtained by regression techniques. Numerical methods therefore appeared to offer immediate advantages in upper-air forecasting for civil aviation, and the transatlantic airlines at Heathrow agreed in principle during the summer of 1965 to accept numerical products for both flight planning and documentation. The numerical prediction output was planned with this application in mind. A dedicated facsimile circuit was installed from Bracknell to Heathrow, and from October 1965 computer forecast charts were sent on this so that a thorough quality evaluation could be made. During the next six months, checks of various kinds were made and reported to Met.O. 7, and from August 1966 routine comparisons were made daily of the equivalent headwinds predicted on great circle, rhumb line and polar curve tracks across the Atlantic by both numerical and the traditional subjective methods. Computer produced charts became available on a 24-hour basis from late September 1966 and the output included not only the necessary operational 18-hour forecasts but also charts for 24, 30, 36 and 42 hours ahead; these provided back-up to cover the risk of computer breakdown for up to 24 hours (Freeman 1968).

Numerical products were introduced operationally on 23 November 1966. This is an important date in Heathrow Met. history because it marks the end of an era of upper-air forecasting by traditional methods. Despite occasional gross errors, forecast upper-air charts prepared by dedicated and experienced staff using gridding

techniques had been shown capable of achieving high and internationally respected standards, but the statistical evaluation established that on average the numerical products were superior and that the time for change had come.

Interestingly, during similar comparisons made six years previously at the National Meteorological Centre in Washington DC, records were kept of individual performance. It was found that one or two highly respected forecasters consistently obtained better figures than were achieved by the early numerical model then used, but even at that stage the overall results appeared to favour the numerical approach. Moreover, although there was little scope for improvement in manual techniques, numerical prediction was then still in its infancy and was, rightly, thought capable of considerable development.

The Upper Air Forecasters were in no sense made redundant immediately by the adoption of numerical predictions for the standard levels. It was essential to maintain 'common sense' monitoring of the computer output, and on at least one occasion a serious fault in data processing led to completely erroneous forecast charts over North America (Freeman 1968). Although the computer output included grid-point values of geostrophic wind, it also remained necessary to make subjective corrections for ageostrophic effects, in particular trajectory curvature, and to take account of recent AIREPs when drawing isotachs; 300 mb charts were still plotted and analysed as a routine to help with these processes. Tropopause and maximum wind charts were also still necessary in order to specify winds and temperatures at altitudes between standard pressure levels as required for flight planning and documentation. However, there was a substantial overall reduction in the analysis and prognosis work, and in March 1967 one of the two analyst posts was deleted. In June 1968, the computer output was enlarged to include spot winds and temperatures for Eumed routes. These had to be monitored, but the following month it was decided that this could be done by the outstation forecaster and the wind forecaster post was abolished; this left only one Upper Air Forecaster in place of the three employed before the days of numerical prediction.

Heathrow Met. as an ICAO Area Forecast Centre

During the immediate post-war years, bilateral arrangements were often made between meteorological offices at departure and destination airfields to exchange forecasts for the remote halves of long routes. When the distribution of basic meteorological data was improved, major forecasting centres became largely independent, but this implied much duplicated effort and also introduced potential difficulties for both flight planners and air traffic controllers. Flight dispatchers in the PAA European Operations Centre at Heathrow during the late 1950s sometimes complained that upper-air charts for evening transatlantic departures from London, Prestwick, Shannon and Paris all predicted different positions for a mid-Atlantic upper low, making optimum track selection difficult. Having vigorously interrogated the Heathrow Upper Air Forecaster, PAA usually planned all flights from Europe on the Heathrow charts, but other companies followed the letter of accepted practice at that time and planned each flight on the charts issued by its final departure airport. This could and did lead to air traffic control problems in that aircraft on similar tracks might then gain or lose different amounts of time on flight plan and so potentially erode safe separation.

The problem clearly called for an international approach, and it was also recognised that by no means all meteorological services could, from their own resources, prepare flight forecasts for increasingly long stages. Although information could be exchanged in figure code messages, this was tedious and facsimile offered a much better solution. Washington started broadcasting area forecasts by radio-facsimile, and in June 1963 Heathrow Met. followed suit with material relevant for transatlantic flights. The general problem was studied in detail by a WMO Working Group on Area Forecasting which met in Geneva in November 1963, and at the ICAO MET/OPS Division Meeting in Paris during January and February 1964. There was general agreement on the need for a world-wide Area Forecast System and, pending

development of that, Regional Air Navigation (RAN) Meetings were encouraged to proceed for their own Regions.

Heathrow Met. was in due course designated by the EUM RAN Meeting as the AFC for westbound transatlantic flights from any part of Europe. The output required consisted of fixed time forecast charts for 700, 500, 300, 250 and 200 mb, also Tropopause / Maximum Wind and Significant Weather Charts; new issues were required every six hours, for facsimile broadcast eight to eleven hours before time of validity (Freeman 1968c). Although use of the material was optional rather than mandatory, it was essential to make it available to all potential users. In addition to the UK HF radio-facsimile broadcast, landline facsimile circuits were installed from Heathrow to Paris, Frankfurt, De Bilt and Copenhagen; Frankfurt agreed to re-transmit the charts by LF radio-facsimile to ensure wide availability throughout Europe (Freeman 1968b). Although Heathrow had been originating material of this kind since June 1963, the area eventually allocated under the new system was very large, covering flights from Europe to Alaska and to the Caribbean. The 1:15 million charts used since 1946 were not adequate for this, and in January 1967 ICAO agreed to the use of 1:20 million charts for a short trial period; these covered the entire area except the southern Caribbean, proved acceptable in trial and continued in use.

On 1 October 1967, Heathrow Met. formally became an AFC under the new ICAO Area Forecast System, responsible for the area designated by the EUM RAN Meeting. On the whole the new procedure worked very well for many years and was not replaced until 1984. Charts from other AFCs including Washington, Paris, Rome, Frankfurt and Nairobi were received at Heathrow where they provided considerable help in preparing documentation for the really long flights.

The Move of Upper-air Analysis to Bracknell

The operational introduction in November 1966 of numerically produced charts certainly strengthened the case for Heathrow Met. to become an AFC under the ICAO plan, but it also marked the first break in complete independence. For the first time since the late 1940s, some of the information supplied for flight planning and documentation was based on externally produced material; admittedly the numerical charts had to be monitored carefully, and to an extent modifications had to be made, for example to sharpen the horizontal shear on the cold side of jetstreams, but the framework was no longer home grown. With the two parties involved physically separated, it was not always easy to preserve entirely consistent advice, and the only way in which the two teams could be brought together was for the Heathrow upper-air bench to move to Bracknell and so also eliminate a certain amount of duplicated effort.

There was preliminary discussion of these ideas in March 1971, detailed arrangements were subsequently made, and the entire Heathrow upper-air section which produced the Atlantic Upper Air and European Spot Wind Charts moved to CFO on 2 November 1972. This led to a significant reduction of staff at Heathrow, as a roster of Supervisors and some assistant posts were deleted as well as the roster of Upper Air Forecasters. Five years later in December 1977, a formal proposal was put forward by C.Met.O. for the return of the aviation upper-air section to Heathrow; this suggestion was subsequently discussed at Bracknell, but as an attempt to swim against the tide the idea went no further.

Met Services for Concorde

In May 1964, BOAC started a paper planning exercise for transatlantic flights by a projected supersonic transport (SST) aircraft and requested daily actual and forecast charts for the 100 mb level. As previously described, 100 mb charts had been drawn at Heathrow since April 1960 and despite the early experience with 200 mb charts it was decided that similar problems would not occur at 100 mb and that forecast charts for this level could be produced by extrapolation without gridding. It soon became evident that wind forecasting for the SST would be nothing like as difficult as that for jet aircraft which flew near the LMW. As the precise operating altitude of the

SST was not known at this stage, from March 1965 to November 1966 charts for the 50 mb level were also plotted and analysed once daily, and here too there seemed to be no great problems. The paper planning exercise terminated in November 1966, and 100 mb chart plotting was temporarily suspended in March 1967.

Just over a year later in June 1968, BOAC started a second series of simulated SST flights, this time by Concorde, and the analysis of 100 mb charts re-commenced; 70 mb charts were also prepared because daily forecasts were requested for that level as well. This exercise ran until March 1971 and 70 mb charts then ceased. One early conclusion from this second paper exercise was that the climb and acceleration phases of SST operations would be critical, and in February 1969 BOAC made a formal request for vertical cross-sections covering these portions of all flights.

In view of the pioneering nature of supersonic flight at high altitudes from the meteorological as well as other points of view, it was decided by Met.Office HQ that Heathrow Met. should be responsible for all SST forecasting in the UK. The maiden flight of Concorde 002 from Filton was on 8 April 1969 and the first supersonic flight in March 1970 from Fairford where development flying was based. A subsidiary forecasting office had been set up there at the end of 1968 and a special facsimile line was installed from Heathrow to bring advisory forecast material; this line was transferred to Filton in May 1979. Flying trials of various kinds continued at Fairford for several years; in the later stages there were many flights on long routes to the south, e.g. to Las Palmas in January 1973. Throughout this period the French Concorde 001 was undergoing similar trials in France, but in October 1974 it flew to Gander from Heathrow where it received full documentation and briefing.

British Airways (BA, formed by the merger of BOAC and BEA) started proving flights with Concorde from Heathrow to Bahrain in July 1975 and across the Atlantic the following month. Scheduled services finally got under way to Bahrain in January 1976 and to Washington in May 1976; services to New York started in November 1977 but the Bahrain schedule was withdrawn in October 1980. In April 1983 Heathrow Met. was offered two seats for familiarisation flights to New York on Concorde. In August 1976, not long after the start of scheduled services, it was decided to inaugurate a new category of warning aimed specifically at Concordes of BA and Air France. These were styled SIGMETSST and were issued as necessary by Heathrow Met. for the London and Shanwick FIRs; originally these included significant weather above 25,000 ft, but in February 1979 the lower limit was raised to 40,000 ft. A special very-high-level Significant Weather Chart specifically for Concorde services was also introduced in October 1976; this omitted a great deal of irrelevant information that applied only to levels well below Concorde operating altitudes. As the flying experience with Concorde accumulated, BA decided in 1980 that 400 mb wind data, also the cross-sections for the climb and acceleration phases were no longer required. Heathrow Met. clearly felt a special responsibility for Concorde flights, having been associated with them from the earliest days. Whenever necessary, special 150 and 100 mb charts were prepared for off-schedule flights to unusual destinations, e.g. to both Barbados and Singapore in February 1984. 100 mb charts were analysed locally until May 1985, many years after all other upper-air work had passed to CFO; before this however, both BA and Air France had agreed to accept computer products, and from April 1984 these were supplied in place of the manually drawn versions.

The Gradual Transition to Self-briefing

The preparation of TAF sheets for every flight was a major and labour intensive part of documentation, and in 1968 it was decided to introduce some changes. As an opening move, two versions of the TAF sheets for Europe were prepared, one in the traditional, hand-written, plain language form, and the other using ICAO indicator letters instead of airport names and giving the TAFs in figure code as received. After three months with the dual system, plain language versions were no longer supplied for Internal and Eumed flights. In May, Xerox copies of the teleprinter messages were substituted for the written figures and this procedure was also introduced as an alternative for the Atlantic crews who soon found them quite acceptable. From July

1968 therefore, Xerox copies of TAFs in code became the norm for all flights and it was possible to delete seven Assistant posts from the established complement.

At this time personal briefing was still considered by the Met.Office as a normal, and indeed obligatory part of aircrew preparations before take-off, but an increasing number of airlines did not view it in this light and when the weather was straight-forward, arranged for documentation to be collected by runners rather than by the crews themselves or by dispatchers. A staff instruction was issued by C.Met.O. in July 1968 that all documentation collected in this way should be endorsed "Subject to amendment at briefing". But it became difficult to maintain this stance when crews did not always feel the need to attend meteorological briefings personally; moreover, Heathrow Met. itself had, for its own convenience, broken the principle in 1962-1963 when the Northside Briefing Office was closed down before PAA and other major companies had moved to the CTA.

In February 1969, there was a prospect of cargo services being operated from the Southside of the airport rather than the CTA, and on request Heathrow Met. agreed in principle to supply material for self-briefing at the Cargo Terminal (which in the event did not open until January 1971). That summer, approval was sought from Met.O. 7 and BOT for a limited experiment in self-briefing in the Queens Building. This was introduced for all Internal flights from Heathrow on 1 November 1969. A special display was created in the Briefing Foyer, consisting of copies of the latest 3-hourly European and hourly British Isles charts, plus Significant Weather and 400 mb upper-air Charts, together with details of recent SFLOCs and current SIGMETs. After helping themselves to appropriate documentation sheets which were placed in pigeon holes, the crews could either leave it at that or discuss matters with a forecaster in one of the Briefing Bays.

The Internal crews soon became accustomed to the new procedures and in September 1970 Eumed operators were asked if they too would accept self-briefing. It took some time for the idea to be cleared by them, by Met.O. 7 and by BOT, but eventually self-briefing was introduced for Eumed routes in December 1972 with new permanent display boards and pigeon holes, also re-decoration of the whole briefing area. Some minor changes were made in the light of experience, but the arrangements worked well and quickly became generally accepted. The number of requests for personal as well as self-briefing naturally varied with the weather, but two Bay Forecasters were normally adequate. Indeed, by April 1979 it was possible to run with only one Bay Forecaster for most of the 24 hours, and the second one was thankfully re-deployed as an assistant to the General Forecaster, (whose work load had increased significantly following the withdrawal of forecasters from Hurn), although he still had to help in the Bays during rush periods.

Personal meteorological briefing of civil aircrews followed a long tradition and remained an option even after the general introduction of self-briefing at Heathrow. However, towards the end of the 1970s CAA initiated a discussion at the British Civil Aviation Standing Conference about the need to retain this option at major airfields. Not surprisingly, opinions on the subject were at first far from unanimous. An airline based at a non-state airport where there was no meteorological office argued that it would not miss what it had never enjoyed, whilst airlines who had for many years used and appreciated personal contacts with forecasters were reluctant to forego the option. However, after a lengthy process of internal consultation within the airlines, it was conceded that a majority of their aircrew no longer regarded personal meteorological briefing as essential. (It is interesting to note that the view of meteorological briefing held by the Royal Air Force was directly contrary to this new stance adopted by civil aviation.) From CAA's point of view, this policy decision opened up the prospect of considerable cash savings at a time of increasingly harsh financial constraints, and inter alia made it unnecessary to include personal briefing facilities as part of the new accommodation in the Control Tower due to be occupied by Heathrow Met. in 1981 (see later). Documentation continued to be prepared for collection by long-haul flights but even this ceased in April 1985. With hindsight it is clear that this change of policy about personal briefing had significant implications for

Heathrow Met. in that it removed one of the reasons for its existence as a forecasting office on the Airport.

Transtels and OASYS

In May 1975, C.Met.O. learnt of Met.Office plans to develop remote computer terminals with automated chart plotting facilities, and that the first installation of the Outstation Automation System (OASYS) was likely to be at Heathrow; this promised substantial staff savings and also the supply of basic meteorological information directly tailored to local needs. When CAA subsequently revealed their plans to re-house Heathrow Met. in the Control Tower Building (see later), it was hoped that the two projects would come to fruition simultaneously. However, by late 1978 it was evident that OASYS might well become available long before the new Tower accommodation was ready and CAA was asked to consider the possibility of funding the works services needed to install OASYS temporarily in the Queens Building.

Quite apart from the obvious financial implications of this, there were added complications due to the possible need to screen the automated equipment and the doubt as to whether BAA would agree to structural modifications in their building only a year or so before premises were vacated. As a possible way round these difficulties it was suggested in July 1979 that the sensitive equipment might be installed in a Portakabin; BAA agreed that this could be done, but pointed out that planning permission would have to be obtained from Hounslow Borough Council to locate this outside the Queens Building and that it would certainly take a long time to do that.

At this juncture, a solution emerged from an unexpected quarter. In September 1976, CACC had given a most impressive demonstration of 200 baud reception of the MOTNE broadcasts on Transtels, the new so-called 'silent' teleprinters; during the following summer CAA installed a Transtel machine for a trial period in the TAF Bay and this confirmed that the Transtels were well suited to routine meteorological data reception. Meanwhile, Met.O. 5 had been developing a system for the transmission of a number of teleprinter broadcasts, each one using a unique schedule designed to meet the needs of priorities of the recipient; the broadcasts would have to be sent on dedicated circuits but could be received on Transtels positioned near the points of use. Having had a very favourable impression of Transtels during the CAA trial in the TAF Bay, the Met.O. 5 proposal to install the new system at Heathrow were warmly welcomed, and by August 1979 five direct circuits from Bracknell had been put in, terminating at Transtels in the Forecast Room.

Though much less noisy than the traditional Type 15 teleprinters, the Transtels did produce an irritating buzzing sound, but once efficient covers had been obtained, the system worked very well; it was vastly superior to the inefficient mechanical message delivery systems used briefly in the Forecast Room during the 1960s and eliminated a great deal of walking about by the communications assistants.

It was then realised that if the remaining meteorological data channels were re-engineered to Transtels in the Forecast Room, the Teleprinter Room would no longer be needed and the space could easily be re-furbished to provide a temporary home for OASYS. Having taken into account the substantial staff savings OASYS would bring, CAA agreed verbally in December 1979 that the proposal should go ahead. The necessary Transtels were installed in January 1980, financial approval for the conversion of the old Teleprinter Room was given in March, the work was put in hand at once and was completed before the end of July. During the first half of August two processors, two pen plotters, two electrostatic plotters, two disc drives and two consoles were installed, and after several months of development work on both hardware and software, a very short 6-day operational trial was mounted in the New Year.

OASYS became fully operational at Heathrow on 19 January 1981 as the data processing heart of the office. It had been programmed to produce almost all the charts needed, the only manual plotting which continued for a time being the large-

scale hourly charts of Southeast England, 100 mb charts, AIREPs and UK tephigrams at non-standard hours, and most of these items were taken over by OASYS in the autumn of 1982. The promised staff reduction of 16 assistant posts took place at once, and after that the operational output could not have been maintained without OASYS. It was fortunate indeed that a second OASYS, intended for installation elsewhere, was made available to equip the new office in the Tower; this was put in place between 7 and 10 July and became fully operational on 13 July 1981, just two days before the move, after which the original OASYS was recovered from the Queens Building for installation at another outstation.

The Control Tower Office

In 1965, BAA took over Heathrow Airport including the Passenger Terminals and the Queens Building but not the Control Tower; that was passed in 1972 to CAA which then became responsible for ATC, AIS, Flight Clearance (FC) and also for Heathrow Met. which as its agent provided the Airport meteorological services. Of these four units, only ATC was located in CAA premises, the other three being tenants of BAA in the Queens Building where, as described earlier, the working environment had fallen well below acceptable standards. CAA evidently decided that the optimum solution to this problem which they had inherited from BOT was to provide new homes for AIS, FC and Met. in their own Tower Building.

C.Met.O. first heard of this tentative scheme in November 1975 and during the next few months the idea was discussed both on the Airport and at Bracknell. In April 1976 CAA asked C.Met.O. to formulate proposals for future accommodation needs, taking into account developments in telecommunications, documentation and briefing expected during the next three years. As Heathrow Met. had asked to be re-housed eight years previously this request was very welcome and the plan was promptly agreed in principle by the Met. Office Directorate. During the autumn and winter, detailed plans were prepared for a suggested meteorological suite on the ground floor of the Tower Building; provision was made for OASYS and the plans were submitted both to Met.O.7 and to CAA in February 1977.

As the overall redevelopment scheme matured, CAA decided to locate AIS, FC and Met. together on the first floor, in an area to which there was convenient direct access for aircrew from a rear door. The CAA Capital Projects Board met at Heathrow in August 1979 and inter alia saw for themselves the sub-standard environment in the Queens Building, including Heathrow Met. The Board later authorised the entire project to go ahead, financial approval was given in March 1980, work contracts were signed the same month and it was hoped the conversion would take no more than a year. In the event it took a little longer than this, but Heathrow Met. became fully operational in its new home on 15 July 1981.

A large foyer at the top of the stairs leading from the rear door gave direct access to Forecast Room, TAF/Documentation Room, Facsimile Room and the administrative offices, also to the large room in which AIS, FC and the CACC sub-centre were located. In the centre of the foyer was an aircrew self-briefing area with display boards and pigeon holes for documentation sheets. The Civil Aviation Standing Conference having accepted that personal meteorological briefing was no longer necessary, there were no Briefing Bays and the five HSO posts attached to them were deleted, reducing the established staff complement to little over 100. Dispatchers and aircrew from most airlines visited the self-briefing area to collect material for flight planning and documentation, but BA had decided to install a 4" direct loop Lamson Tube system to bring charts from Heathrow Met. to their operations unit in the Queens Building; this was not in working order until February 1982.

As all the upper-air work had been moved to Bracknell in 1972, the Forecast Room of about 1650 sq ft was much more compact than that in the Queens Building, but the space was ample and in no way cramped; the room itself was well lit, double-glazed and fully air-conditioned, as indeed were all the other operational rooms. The Computer Room housing OASYS led directly from the Forecast Room, and beyond that was the TAF/Documentation Room equipped with three Xerox machines. The

Facsimile Room and adjoining Area Maintenance Centre came next while across the foyer was a corridor leading to four rooms for C.Met.O. and his staff, a Library and a Store Room; Staff Rest Rooms on the first floor became available in January 1983. During the first six months or so there were some problems with the air conditioning and with misting between panes of the double glazing, but these were minor troubles and the working environment was a vast improvement on that in the Queens Building.

One notable feature of the Control Tower Office was the range and sophistication of the telecommunications and data processing facilities. Centre stage was OASYS which in January 1982 was enhanced by VDU access to the data store so that, over and above the substantial routine output of charts and other processed material from the pen and matrix plotters, forecasters on the bench could request alpha-numeric or graphical presentations from a menu of programmed options. There was also VDU access to the CACC database from which OPMET bulletins and AFTN messages could be retrieved and displayed, with hard copies available at 300 baud on a Transtel if required. The CAMFAX broadcast originated by Heathrow Met. was sent on land-line circuits to over 20 civil airports in the UK. Primarily to help the smaller airfields where there was insufficient traffic to justify connection to CAMFAX, there was also a DOCFAX machine with which graphical material could be transmitted using ordinary telephone lines. In March 1984, when the output on DOCFAX had expanded considerably, an additional automatic DOCFAX transmitter was obtained; this could be programmed to send a chart to a sequence of telephone numbers. Four facsimile circuits were used to send all the London AFC products away for international distribution, and to receive similar products issued by the AFCs at Paris, Offenbach, Rome, Nairobi and Washington; a further three circuits were used to receive the broadcasts of MOLFAX, SATFAX (satellite imagery), and PANFAX (upper-air charts and numerical predictions prepared at CFO for civil aviation). The special needs of Concorde development at Filton were served by a dedicated facsimile circuit. OPMET broadcasts and AFTN messages from CACC were received on Transtels, as were basic meteorological data sent by MCC Bracknell. If this résumé of data reception, processing and transmission facilities had been described to a forecaster in the Northside Office 30 years previously, it would have seemed like a piece of science fiction.

Both the working environment and the facilities in the Tower Office were planned with meticulous care and it is sad indeed that after enduring the Queens Building for so long, the near ideal home was enjoyed by Heathrow Met. for less than seven years. With hindsight it seems to be yet another example of the well known apparent paradox that "Perfection of planned layout is achieved only by institutions on the point of collapse". **For further illustrations of this see : C.Northcote Parkinson "Parkinson's Law" 1958.

The revised ICAO Area Forecast System

In 1979, ICAO decided to review the Area Forecast System introduced in 1967 under which Heathrow Met. had AFC responsibilities for westbound flights from Europe across the Atlantic. Recommendations for a new system were developed by an Area Forecast Panel which met in 1980 and again in 1981, and were discussed and agreed at the ICAO COM/MET Division Meeting at Montreal in April 1982. Central to the new plan was the belief that the upper wind and temperature requirements of jet aircraft, especially those on long flights, are most efficiently met primarily by numerical prediction techniques applied globally. Although world-wide data can be produced by one centre, to safeguard against computer breakdowns and to ease communications two World Area Forecast Centres (WAFCs) were proposed, both running global models on fast and powerful computers. Regional Area Forecast Centres (RAFCs) would receive WAFC products, distribute such parts of them as were needed regionally, and also prepare regional Significant Weather Charts. Washington and Bracknell were designated as the two WAFCs, and one of the RAFCs was also assigned to the UK; it seemed appropriate to locate this too at Bracknell. C.Met.O. attended the COM/MET Meeting as a member of the UK delegation and was subsequently appointed Chairman of the UK Implementation

Working Group which met from time to time throughout 1983 and early 1984; there was also informal discussion with representatives from France and Germany. As a step towards implementation and the elimination of duplicated work, CAA insisted in June 1983 that AFC Frankfurt material should be used for planning and documentation of all flights from the UK to Europe; Heathrow Met. therefore ceased production of the Eumed Significant Weather and Spot Wind Charts and substituted, both locally and on CAMFAX, the Frankfurt charts for 850, 700, 500, 300, and 200 mb, also Tropopause / Maximum Wind and Significant Weather Charts. This move was initially unpopular with the aircrew at Heathrow but came to be accepted. (Preparation of UK Spot Wind Charts continued, to cater for Internal flights.) C.Met.O. also attended a meeting in Frankfurt during October 1983 to discuss general implementation problems in Europe with representatives of RAFC Frankfurt, RAFC Paris and CAA. It was agreed that the new Area Forecast System would be fully operational throughout Europe by 1 February 1984, but the USA was unable to pick up its new RAFC responsibility for the Northwest Atlantic until mid-March. The Heathrow AFC commitment then came to an end and at the end of the month 13 posts were deleted from the established complement, bringing the total strength below 100.

The contents of CAMFAX broadcasts originated at Heathrow were amended in accordance with internationally agreed arrangements to include Significant Weather Charts for the North Atlantic (Bracknell), Europe and North Africa also Middle and Far East (Frankfurt) together with Europe to Caribbean also Europe to Africa (Paris). The upper-air charts were for convenience generated at Heathrow on OASYS but were derived from grid-point data produced by WAFC Bracknell; 300, 250 and 200 mb data were sent for all areas, with 500 mb data also over the North Atlantic and 850, 700, 500 and 400 mb data also over Europe.

General Aviation

Heathrow Met. was established primarily to serve the airlines which operated from the Airport, but it also provided a back-up service for its outstations at airfields like Hurn which were used as diversions for Heathrow, and when airline services started at Southend and later Luton it met their needs as well. However, in addition to airline operations there is also General Aviation (GA) e.g. private pilots, air-taxi operators, flying clubs and training schools, executive aircraft and so on. The large bulk of GA is based at smaller airfields, many of which do not have meteorological offices and therefore have to obtain what weather information is needed from designated forecasting offices which are listed in the Air Pilot. During its early days, Heathrow was only involved with GA to a very limited extent, for example by providing local area forecasts to Southend, but this position changed significantly in 1973 when the MMO for ATCC West Drayton was closed.

Heathrow Met. then inherited responsibility not only for a number of smaller airfields (bringing the total dependent on Heathrow up to 20) but also for the issue of General Aviation Visual Flight Forecasts (GAVFF) covering the London FIR. These were made available as a recorded information service on public telephone lines with the object of reducing the number of calls made by GA to forecasting offices. Short 6-hour forecasts for small areas are recorded every three hours from 0500 to 1700; these are adequate for local and short cross-country flying at altitudes below 5000 ft under Visual Flight Regulations (VFR). If VFR conditions are indicated, the caller has all he needs; if not, then flying can be cancelled or further advice be sought from the forecasting office designated in the Air Pilot. Shortly after its establishment in 1972, CAA asked the Met.Office to gather regular data from all its outstations about current GA demands for weather information. Early returns confirmed the low level of Heathrow Met. involvement, with only some 50 enquiries per month including routine issues. However, the closure of the MMO for West Drayton brought an immediate increase in this figure to around 600 per month and from then onwards the trend was steadily upwards, reaching over 1000 in peak months during 1977 and over 3000 a month in 1979, more than 1000 of this last figure being requests for flight forecasts to overseas destinations. When forecasters were withdrawn from Hurn, Heathrow

became responsible for another five GA airfields; when forecasters were also taken out of Stansted in 1980, the list of airfields dependent on Heathrow Met. rose to 28.

By the 1980s, the needs of airlines throughout the country were largely met by CAMFAX and OPMET broadcasts, but demands from GA were increasing. Forecasters were withdrawn even from Gatwick in September 1983, and forecasters at Heathrow had to spend a disproportionate amount of time on GA work which was labour intensive because it entailed individual written area or route forecasts for transmission by telephone or teleprinter; similar difficulties on a smaller scale had also arisen at the civil aviation MMOs at Manchester, Prestwick and Aldergrove. The problem was very similar to that which had occurred during the late 1950s with individual flight forecasts for airlines, and in discussion between CAA, C.Met.O. and Met.O. 7 early in 1983, it was agreed that a similar solution seemed to offer the best way forward. From June 1983, Heathrow Met. prepared Low Level (below 15,000 ft) Significant Weather Charts covering the UK and very-near continent five times a day and to ensure a consensus of view within the UK held a conference by telephone before each issue with the MMOs at Manchester, Prestwick and Aldergrove. Spot Wind Charts (up to 24,000 ft) were generated four times a day by computer at Bracknell. Transmissions on CAMFAX sent the charts to the MMOs and to many airfields (e.g. Cambridge) where GA was based; other airfields could receive the charts on DOCFAX and in September 1983 CAA provided transmission facilities for this at Manchester and Prestwick. Route forecasts within the Low Level Significant Weather Chart area were then no longer issued to airfields equipped with facsimile and the system certainly reduced the overall workload; Heathrow benefited even more in March 1984 when CAA installed DOCFAX at Southampton, Biggin Hill and Fairoaks. All GA airfields were encouraged to install DOCFAX and a number did so. An automatic transmitter which could be programmed to send the same chart to a sequence of telephone numbers helped considerably and with two of these, by January 1987 Heathrow Met. was dispatching 266 charts a day to GA airfields. The Heathrow Met. area of responsibility was widened still further to include South Wales, Southwest England and East Anglia, and by the end of 1987 it was listed in the Air Pilot as responsible for no fewer than 45 airfields.

Although the 1983 reorganisation eliminated a large proportion of GA route forecast requests, many area forecasts still had to be prepared for local flying, especially at the smaller airfields whose only form of communication with the outside world was a telephone line. In June 1987, CAA introduced AIRMET forecasts for Southern Britain to replace local area forecasts. Written forecasts were prepared four times daily for dispatch on AFTN and for recording on the public Telephone Information Service; the schedule of Low Level Significant Weather Chart issues was changed to four times a day at the same time, the validity periods being identical. This final change in the services for GA was by no means universally popular with the recipients; in particular those dependent on the telephone felt that a lifeline of personal contact and advice had been cut. The cost of AIRMET is clearly less than that of providing a service tailored to the needs of may individual airfields, but whether or not it proves to be of long term benefit to the GA community remains to be seen (see Pike 1988, also letter in Weather Vol. 44 1989 p 137).

Transfer of Aviation Forecasting to CFO

Although the complete independence of Heathrow Met. was slightly dented by the introduction in 1966 of output from the numerical prediction model run on the Bracknell computer and by the consequential transfer in 1972 of the upper-air section to CFO, its dominance in the provision of meteorological services for civil aviation in the UK remained essentially unassailed until after the move to the Tower in 1981. But from then onwards the position changed so quickly that within five years it was decided that no forecasting at all was needed at Heathrow, and some comment must be offered on this sudden demise.

The preparation of terminal forecasts for airfields is a key requirement, calling not only for understanding of the evolving meteorological situation but also for a thorough knowledge of local meteorological characteristics. For obvious reasons,

this task was normally carried out by a forecaster on the spot, but the Local Forecaster at Heathrow had always been required to originate and issue long, and occasionally short TAFs for Heathrow satellite airfields such as Hurn where the forecasters on the spot did not maintain a 24-hour watch; TAFs were also later issued for non-state airfields like Southend where there was no meteorological office at all. This commitment was always taken very seriously, and the necessary local knowledge was obtained through detachments, visits and the availability at Heathrow of the Local Forecasters' Gen Book described earlier. Despite this limited departure from the principle of local preparation for terminal forecasts, when trends were introduced the Met.Office ruled that they could be originated only by a forecaster on the spot. This view remained as policy for many years, but in 1978 CAA questioned its validity, and at their instigation trials were arranged in which TRENDs for Stansted and Gatwick prepared locally in the normal way were compared with versions of them produced simultaneously and independently at Heathrow. The results of these trials were mixed and inconclusive but did not prove that the locally prepared versions had any clear and consistent superiority. Inevitably, this outcome by inference diminished the case for retaining forecasters at airfields as a matter of operational necessity.

A second significant development was the success of self-briefing and, as previously described, the subsequent acceptance by the British Civil Aviation Standing Conference that personal briefing was no longer essential; this new policy was implemented at Heathrow when the office moved to the Tower in July 1981 and the option of personal briefing then effectively disappeared. A third, extremely important factor affecting the eventual outcome was the agreement in 1983 between CAA and the Met.Office that the new ICAO RAFC should be located in CFO rather than at Heathrow and the consequential transfer also of responsibility for SIGMET issues affecting the Shanwick and London FIRs. This marked the end of Heathrow Met's position as a key centre in the ICAO Area Forecast System. Throughout the 1980s, the Met.Office was under severe manpower and financial constraints, and as part of a comprehensive review of services in the public domain, in 1986 those in the south-eastern part of England received detailed attention. The Study Group, which included representatives of CAA as well as the Met.Office, found that if the remaining aviation forecasting commitment at Heathrow were transferred to CFO, there would be significant overall staff savings and by implication a lower charge to CAA for the meteorological services supplied by the Office on an agency basis. Neither party felt any overriding need to retain forecasters at the Airport, so the Group recommended that the move should be made; this action was subsequently approved by DG Met.O. and by CAA. The necessary arrangements for the move took about eighteen months to complete and the curtain was finally lowered at Heathrow on 23 March 1988.

Envoi

The forecasting office at Heathrow was set up on a shoestring during the immediate post-war period, but soon established an internationally respected tradition of personal and effective service; there was a sense of partnership, both with the airlines and in the development of civil aviation meteorology, that brought its own reward despite all the hard work involved in meeting the challenge of new requirements for jet and later supersonic aircraft. When it closed 42 years later, Heathrow Met. was part of another world of sophisticated computer and telecommunications technology and the service offered was largely impersonal and on a self-help basis. Several thousands of staff must have served at Heathrow during its lifetime, some of them for weeks, others for decades; there were undoubtedly those who disliked both the work and its location, but there were also many, including the author, who remember their days on the bench there with satisfaction at what was achieved, and it is important that this achievement should not be forgotten.

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APPENDIX

Senior and Chief Meteorological Officers at Heathrow 1946-1988

Until June 1956, the officer-in-charge of Heathrow Met. was a Senior Meteorological Officer of PSO grade; the post was then re-designated Chief Meteorological Officer and was upgraded to SPSO. For nearly twelve years, there was no post as deputy, one of the Senior Forecasters being relieved of bench duties to stand in as necessary. In December 1957, a full time Deputy C.Met.O. post was created; this was originally a CXO post, but was re-graded PSO in September 1967.

S/C.Met.O. incumbents were as follows

G. J. W. Oddie	May 1946 - May 1949
M. J. Thomas	May 1949 - October 1949
J. C. Cumming	October 1949 - March 1952
P. J. Meade	March 1952 - January 1955
T. N. S. Harrower	February 1955 - June 1956
J. C. Cumming	June 1956 - August 1966
M. H. Freeman	August 1966 - January 1970
J. H. Brazell	January 1970 - January 1971
R. E. Farms	January 1971 - March 1976
A. Ward	March 1976 - May 1980
K. Bryant	May 1980 - April 1984
S. J. Caughey	April 1984 - March 1985
D. Forsdyke	March 1985 - March 1988