QUALITY CONTROL, SELECTION AND PROCESSING OF OBSERVATIONS IN THE METEOROLOGICAL OFFICE'S OPERATIONAL FORECAST SYSTEM

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1. Introduction

There are three aspects to the preparation of observations before they can be used in an operational assimilation scheme. These are

a. The quality control of observations

b. The selection of suitable observations for the analysis

c. The processing of the data into a suitable form for use by the analysis.

Before discussing the details of each of these items it is helpful to give an overview of the data preparation part of the Meteorological Office's operational suite. Figure 1 is a flow diagram of the operational suite up to the end of the assimilation. Observations which are being received continuously over the Global Telecommunications System (GTS) are passed by the Telecommunications Branch into the COSMOS computer system and stored in the Synoptic Data Bank (SDB). The observations are decoded and undergo a number of self consistency quality control checks before storage. As the observations are received they are monitored by forecasters on a Visual Display Unit (VDU) screen (A on Figure 1). The computer draws their attention to observations which differ significantly from the first-guess field (background field) or latest analysis and, by comparing them with manual analyses, the forecasters may choose to reject or correct them. As a matter of principle, modifications are not made directly to observations within the SDB as this may not be desirable for applications other than numerical weather prediction. Rather, a data set is assembled containing all intervention instructions (B on Figure 1). At the start of a run of the operational suite, data are extracted from the SDB, modified or rejected in accordance with the intervention instructions and passed across the IBM-CYBER link to the CYBER 205. Here the data are first processed to calculate 'observed' values of the variables required by the analysis, θ (potential temperature), u, v (westerly and southerly wind components), r (humidity mixing ratio), p_* (pressure at model surface). These are the independent variables of the model. The data are also sorted into latitude bands in longitude order and all types of data are merged together. The

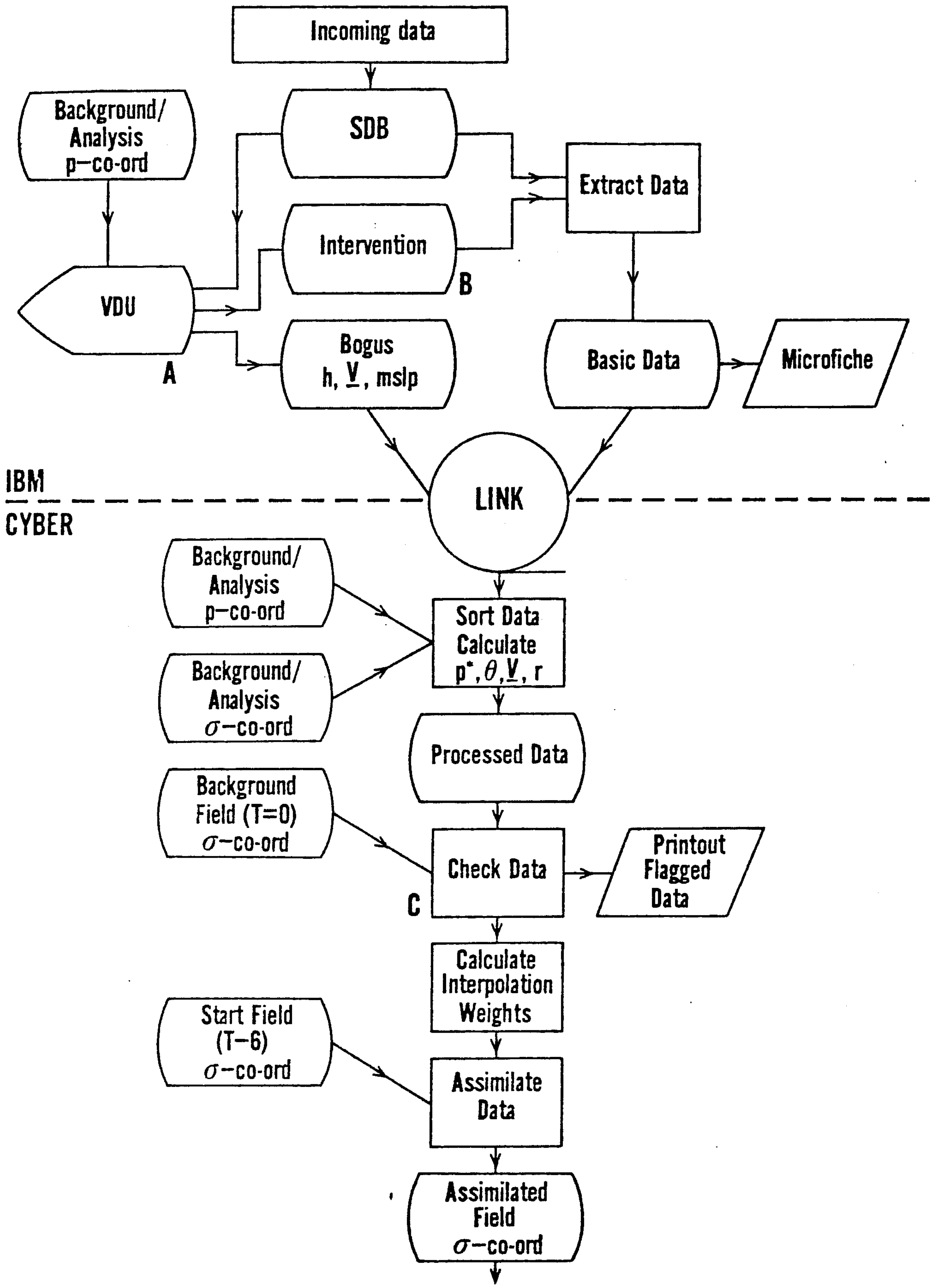

Figure 1. Flow Diagram of the Operational Suite up to the Assimilation.

data then undergo further quality control by checking against the first-guess field and neighbouring observations using univariate optimum interpolation (OI) (C of Figure 1). Optimum interpolation weights are then calculated for observations which pass the quality control checks and they are assimilated into the model.

In the operational schedule at the Meteorological Office data are assimilated into the global model at 6-hour intervals for 00, 06, 12 and 18 GMT. At the time of writing, the 00 and 12 GMT assimilations are performed three times, once at 0200/1400 GMT for the northern hemisphere only, to provide initial data by interpolation for the regional (fine-mesh) model, once at 0320/1520 GMT to provide initial fields for the global model, and once at approximately 1130/2330 GMT which is known as the update run and followed immediately by the assimilation of 06/18 GMT data to provide first-guess fields for the following 12/00 GMT assimilations. It is expected that a fine-mesh assimilation scheme which analyses the data at 3-hour intervals will be introduced during November 1984. This will supercede the hemispheric assimilation run at 0200/1400 GMT.

2. Quality Control

Quality control is carried out in three separate parts of the operational system, within the Synoptic Data Bank, by manual intervention, and by univariate OI immediately preceding the analysis/assimilation.

a. Synoptic Data Bank Quality Control

Details of the SDB quality control are contained in the document annexed to this paper. As can be seen these consist of checks for valid date/time, position etc, self consistency checks, checks against climatological extremes and checks against the background or first-guess field. For the operational suite, the hydrostatic check on all four parts of TEMPs, at Appendix III of the document, is used in addition to the check at para 18. The SDB sets flags against suspect items and sometimes also makes substitutions. The flags are examined during the data extraction and pre-processing stages. In some cases, for example a flag on position, the data are rejected outright at the extraction stage. For radiosonde data, where layer mean values are calculated (see section 4) flagged values are rejected before the calculation is performed. For other data a flag is passed to the OI quality control (the mode 1 flag is set on, see section

2(c)) when an item has been flagged by the SDB. The SDB quality control is in a continuous state of development and there are plans to make improvements in several areas.

b. Manual Intervention

As mentioned in the introduction, forecasters in the Central Forecasting Office (CFO) have facilities to reject or correct observations using a VDU and also to create bogus observations if they are unhappy with the machine analysis. Their attention may be drawn to erroneous data either by using special VDU monitoring programs which compare observations with the first-guess field, or when analysing their charts manually, or, if an observation has slipped through the quality control checks of a previous run of the same analysis, by investigating the reasons for a poor analysis in a particular area. The intervention facilities are under continuous development. At present, forecasters may reject complete observations on an individual basis, reject all observations of the same type within a given three-dimensional volume of the atmosphere and within a given time period, (for example reject part of an orbit of satellite data between the surface and 500 mb), or correct the temperatures and dewpoints from radiosonde observations which have a warm or cold bias throughout the ascent on a particular occasion. The latter correction is performed in terms of a correction to the 100 mb geopotential height and is incorporated by modifying the standard 100 mb bias correction. The application of the bias convection is described by Woodage (1985). Plans for further development of the intervention facilities include the rejection or correction of parts of a surface observation, for example rejecting the pressure only, and the rejection or correction of parts of upper-air observations. A system for setting mandatory flags is also planned. This will allow the forecaster to override the OI quality control and some of the SDB quality control.

Key radiosonde ascents, such as the weather ships and other isolated observations are closely monitored. In exceptional circumstances, for example when a coding error has caused the report to be misinterpreted by the SDB, the observation is reinserted into the communications computer by the Telecommunications Branch and passed back to the SDB as a COR message. (Such COR messages are sent to the SDB only and not sent anywhere else).

c. Optimum Interpolation (OI) Quality Control

At this stage the observations have been converted to the model variables u, v (wind components), θ (potential temperature), r (humidity mixing ratio) and p_* (model surface pressure). The quality control is carried out in two stages. A 'Mode 1' check compares observations with the background or first-guess field. Where the difference exceeds a certain criterion the Mode 1 flag is raised. This flag may also be raised as a result of the SDB quality control (see section 2(a)). In the second step, Mode 2, observations are checked against their neighbours. Observations which have their Mode 1 flag raised are checked again but are not used to check other observations. The Mode 2 check uses univariate optimum interpolation to produce an analysed value at each observation point using neighbouring unflagged observations but not the observation which is being checked. The observation is compared to the analysed value and is rejected if the difference exceeds a specified criterion. Observations which fail the Mode 1 check are reinstated if they pass the Mode 2 check. Note that since univariate OI is used, observations of, say, temperature are checked only against other temperature observations and no appeal is made to such relationships as the geostrophic relationship between geopotential height and wind. Also, if a group of correct observations are all rejected at Mode 1 due to a poor first-guess field, they may not be reinstated at Mode 2 if no correct observations are left against which to check them.

The criteria used in Modes 1 and 2 are as follows. Let x_i^o be an observation at point i, x_i^b be the value of the background or first-guess field and x_i^a the analysed value at that point. Let E_i^{o2} be the observational error variance, E_i^{b2} be the error variance of the background field and E_i^{a2} be the expected error variance of the analysed value at the observation point. The latter may be determined from the OI formalism.

An observation is flagged at Mode 1 if

$$(x_i^o - x_i^b)^2 > n_1^2 (E_i^{o2} + E_i^{b2})$$

An observation is flagged at Mode 2 if

$$(x_i^o - x_i^a)^2 > n_2^2 (E_i^{a2} + E_i^{o2})$$

Details of the formulation of the optimum interpolation scheme including specification of error variances and covariances are given in the Meteorological Office Operational Numerical Weather Prediction System Documentation Paper No. 3.

3. Data Selection

Data selection takes place at a number of different stages in the processing of the observations. The main criterion for the global assimilation is that observations should be valid within 3 hours of the time of the analysis. Similarly, for the fine-mesh assimilation, which will be carried out at 3-hour intervals, a $\pm$ $1^1/_2$ hour interval will be used.

Apart from the above time constraints, the main reason for data selection in the UK analysis system is that there is no facility for combining a number of closely packed observations of the same type to make a single observation with reduced error (often known as 'super-obbing'). It is therefore necessary to thin out observations of the same type where these are liable to be too dense. Some data selection of this type is applied to surface land stations, drifting buoys and AIREPs. The second form of data selection is within the analysis program itself and concerns the selection of observations required for the analysis of a particular grid point.

a. Surface Land Stations (SYNOPs)

The problem with surface stations is mainly in Europe where the UK receives observations for regional as well as global exchange. The use of all observations from Europe during the early days of the trial of the 15-level model, resulted in very rough mean-sea-level pressure fields and this was shown to be caused by the very dense network of observations resulting in almost completely different sets of surface observations being selected by the analysis at neighbouring grid points. It is not clear whether the same problem would occur now that the analysis/assimilation scheme has been improved but it is still considered desirable, partly due to limits in the analysis program on numbers of observations, to reduce the density of surface observations. This is achieved by the use of a station list made up of all surface stations designated by WMO for global exchange plus additional stations selected on the grounds of frequency of reporting, to make up to approximately one station per grid square. Recently, it has been found that, although this is satisfactory in dense data areas such as Europe, it has undesirable effects elsewhere, where for example, there may be two stations close together on a remote island. Here the station list may contain only one of the stations so that there are no redundant observations for quality control purposes. In the longer term it is planned to improve the selection of stations on the station list but, as a temporary measure, an amendment to the extraction program has been made to use the station list for a limited set of WMO blocks, mostly within Europe.

b. Drifting Buoys

Since drifting buoys report once for each orbit on which the interrogating satellite is within range, up to 8 reports may be available to the analysis from the same buoy. This has caused ill conditioning in the OI equations so now only the observation nearest in time to the time of the analysis is used.

c. AIREPs

Problems with AIREPs arise with duplicate reports. These occur because an aircraft reports to more than one air-ground communications centre and the same report may be put on the GTS at two different places. For example reports from the central Atlantic are put on the GTS by both Gander and Bracknell. Because of the free form of the AIREP code the reports are not necessarily identical in character format and duplicates have to be found by checking the content of the message. Duplicate reports are removed at the pre-processing stage on the CYBER. Sometimes apparently conflicting reports are received from the same aircraft ie they have the same call sign, latitude, longitude, flight level and time but different data. In this case both observations are rejected.

d. Data Selection at the Analysis Stage

Ideally all observations within the region of influence determined by the OI structure functions should be used when analysing a particular grid point. However practical considerations of both computing space and time mean that a selection of observations has to be made. The method of selecting observations has to be carefully formulated so that important observations are not inadvertantly ignored. The selection algorithm used in the UK analysis has recently been reformulated in the light of the density of observations available from the locally retrieved satellite soundings (known as HERMES). Details of the selection algorithm can be found in the Meteorological Office Operational Numerical Weather Prediction System Documentation Paper No. 3.

4. Processing of Data

The analysis is performed in terms of the model variables, θ (potential temperature), u, v (westerly and southerly wind components), r (humidity mixing ratio) and p_* (model surface pressure) on the analysis grid. This is identical to the model grid having sigma co-ordinates in the vertical and latitude/longitude co-ordinates in the horizontal except that the number of points per latitude circle decreases poleward of 50° to retain a quasi-uniform horizontal spacing. Before the analysis, all observations are converted into the model variables. Details of the methods used may be found in Woodage (1985). The most significant calculations are the determination of p_* from observations of mean-sea-level pressure, station-level pressure or the height of a geopotential surface, and the calculation of mean values over layers centred on sigma levels of potential temperature, wind components and humidity mixing ratio from both the standard and significant levels of radiosonde ascents.

5. Some Ideas for Quality Control from a previous Operational System

The Meteorological Office's previous operational analysis scheme for the 10-level model contained some techniques for quality control which were very effective but which have not been utilized in the current operational system. These techniques were based on empirical ideas and were very carefully tuned. They were an important factor contributing to the decision to introduce the analysis scheme operationally.

The 10-level model orthogonal polynomial analysis of geopotential height was essentially a sophisticated form of the Successive Correction Method. After each scan of the analysis a high powered polynomial was fitted to the whole field and observations were compared with the latest fitted field. Where the difference exceeded a certain criterion the observations were not used in the next scan. Successive scans used higher order polynomials to fit more detail. Observations rejected on one scan could be re-instated if they passed the quality control checks on later scans.

Some of the quality control checks were designed to overcome known deficiencies in the analysis technique and therefore are not worth discussing here. Two contain ideas which might be applicable within the formalism of optimum interpolation.

a. Criterion for rejecting a height observation by comparison with the latest fitted field.

An observation was rejected if

$$|\text{observation} - \text{latest fitted field}| > A + B\,|\text{Laplacian}|$$

and $|\text{observation} - \text{latest fitted field}| > A + C\,|\text{Gradient}|$

where A, B and C are constants depending on the scan, level and observation density, and the Laplacian and gradient are values interpolated to the observation point for the latest fitted field. Only the gradient check was used in anticyclonic areas with large curvature where the observation was higher than the fitted field. Thus the criterion was relaxed near the centres of depressions and anticyclones or where the gradient was large. This is equivalent to saying that the error in the latest fitted field was liable to be larger in such areas. Such an idea could be applied to the first-guess errors in the application of OI to quality control.

b. <u>Buddy check</u>

In certain situations where a group of observations all differed significantly from the latest fitted field, the quality control was ignored. This was to overcome the problem of a group of good observations being rejected in comparison with a poor first-guess and consequently poor analysis. The precise conditions under which the quality control was ignored were very carefully formulated.

Conclusion

The quality control, selection and processing of observations in the Meteorological Office current operational forecasting system has been described. It is fair to say that less attention has been given to the quality control and selection of data than to other aspects of the operational suite both during its development and following its operational implementation in September 1982. However, the importance of these aspects to the quality of the analysis and hence the quality of forecasts is becoming more widely recognised and it is intended to pursue research along the lines proposed by Lorenc at this Workshop.

Some empirical ideas used in the previous operational analysis scheme have also been discussed. It was relatively easy to formulate empirical methods of quality control for the 10-level model analysis of geopotential height. This used only northern hemisphere extra-tropical height and wind observations, the majority of which were from conventional surface and upper-air stations. The problem is much more complicated in modern global data-assimilation schemes where more variables are analysed directly, the analysis is over a much larger and climatologically more varied domain and the analysis uses a mixture of observation types which may have different kinds of errors some of which may be correlated with each other. Some sort of statistical framework, such as is provided by the OI formalism is therefore needed for quality control. However, it is often necessary to simplify such statistical techniques in order to apply them in practice, and it is important that when such simplifications are made common sense is not abandoned in favour of elegant mathematics.

References

Woodage (1985) 'The preparation of data for the Meteorological Office operational 15-level forecast model'. Met. Mag. Vo. 114, No. 1350 January 1985.

Meteorological Office Operational Numerical Weather Prediction System Documentation Paper No. 3. 'The Data Assimilation Scheme'. Unpublished document available on request from Met O 2b, Meteorological Office, restriction on first page to be observed.

ANNEX

Met O 12c

Technical Note No. 3

Synoptic Data Bank

Quality Control Document

	Para
(ii) Ship Reports	
Valid date and time	1
Valid latitude and longitude	3
Valid position for reported OWS call sign	5
Marsden square consistent with latitude and longitude	7
Duplicate reports within one-degree square	8
850 mb and 700 mb height check (thousand digit)	15
Maximum permitted wind speed for each standard pressure level	16
Windshear check	17
Full hydrostatic check	18
(c) <u>Upper Air</u> - Part A and Part C PILOT	
(i) Land Reports	
Valid date and time	1
Valid WMO Block number and Station number	2
Maximum permitted wind speed for each standard pressure level	16
Wind shear check	17
(ii) Ship Reports	
Valid date and time	1
Valid latitude and longitude	3
Valid position for reported OWS call sign	5
Marsden square consistent with latitude and longitude	7
Duplicate reports within one-degree square	8
Maximum permitted wind speed for each standard pressure level	16
Wind shear check	17
(d) <u>Upper Air</u> - Part B and Part D TEMP	
(i) Land Reports	
Valid date and time	1
Valid WMO Block number and Station number	2
Maximum permitted wind speed for each standard pressure level	16

(ii) Ship Reports	Para
Valid date and time	1
Valid latitude and longitude	3
Valid position for reported OWS call sign	5
Marsden square consistent with latitude and longitude	7
Duplicate reports within one-degree square	8
Maximum permitted wind speed for each standard pressure level	16
(e) <u>Upper Air</u> - Part B and Part D PILOT	
(i) Land Reports	
Valid date and time	1
Valid WMO Block number and Station number	2
Maximum permitted wind speed for each standard pressure level	16
(ii) Ship Reports	
Valid date and time	1
Valid latitude and longitude	3
Valid position for reported OWS call sign	5
Marsden square consistent with latitude and longitude	7
Duplicate reports within one-degree square	8
Maximum permitted wind speed for each standard pressure level	16
(f) SIRS	
Valid date and time	1
Valid latitude and longitude	3
Marsden square consistent with latitude and longitude	7
850 mb and 700 mb height check (thousand digit)	15
Full hydrostatic check	18
(g) GOES/SATWD	
Valid date and time	1
Valid latitude and longitude	3
Valid Octant	4

Maximum permitted wind speed for each standard pressure level	Para 16
(h) AIREPS	
Valid date and time	1

Introduction

This document contains details of the Quality Control checks which are applied to data prior to Storage within the Synoptic Data Bank. It should be read in conjunction with two other documents:-

(1) Met O 12c Technical Note No 2 - wherein is contained a full description of 'report layout' and the format of the quality control bytes. A reference to this document will be indicated by index '1'.

(2) Met O 12c Technical Note 1 - Retrieval of Data - which in addition to describing retrieval methods includes a description of the data bank organization. A reference to this document will be indicated by index '2'.

Many of these checks have been developed from checks applied within the 3-level analysis suite which operated in KDF9. An indication is given in each case regarding the origin of the check as follows:-

KDF9 check - criteria unchanged - index '3'
KDF9 check - criteria modified - index '4'
New check - index '5'

When a query has been generated byte 6 bit 2 of the report[1] is set on.

As a result of quality control checks it is possible to change the value of an element in some cases. A description of such circumstances is included in the document.

Data which cannot be stored in one of the on-line data banks are stored in a special data-set, attached to the appropriate Data Bank, which will be referred to throughout as 'DREGS'. The circumstances leading to storage in this data set will be referred to throughout this document. The fact that data are in DREGS does not inhibit their inspection, but they are not normally available without reference to Met O 12c. A VDU DREG display programme is available in Met O 12.

When suspect or wrong data are detected by the quality control routines, quality control bytes are set up at the end of each report; each element within the report is represented by one bit within the qc bytes. Bits set to 'one' represent suspect or wrong data.

Substitution of Values

Replacement of reported values by amended values is done for several reasons. When a substitution has been made byte 6 bit 1 of the report [1] is set on. The following checks allow substitutions to be made:-

Quality Control Checks

1. Valid date and time --- 5

This check considers the report date and time T_r and the bulletin heading date and time T_h in relation to the base hour H of the data bank, viz 00 or 12 GMT.

If T_r is in the range H-23 to H+11 no further check is undertaken.

If T_r is outside the range H-23 to H+11, is corrupt or is given as '24', T_r may be replaced by T_h. For this purpose T_h is required to be in the range H-23 to H+11. A substitution is then made and byte 6 bit 1 of the report[1] is set on.

In default the report is stored in DREGS.

AIREP reports contain no date. This must be obtained from the bulletin heading in order to ensure that each report is stored in the correct data bank. Accordingly a check is made to ensure that the time is compatible with the date and the latter adjusted if necessary.

eg Bulletin heading 250100 - 0100 GMT on 25th.

Report time 2300 - 2300 GMT

Report is for 2300 GMT on 24th

Similarly on occasions when ony the minutes value of the time is reported reference is made to the bulletin heading date and time and adjustments made to both as necessary.

2. Valid WMO Block number and Station number --- 5

A search is made of a comprehensive station index to find the appropriate WMO Block number and Station number. If the station does not appear in this index the appropriate flag is set on in the quality control bytes[1].

[Byte 0 bit 0 for surface reports, byte 0 bit 1 for upper air reports].

This index is updated every 6 months.

3. Valid latitude and longitude --- 5

A check is made that the latitude and longitude are both sensible values, viz:-

Latitude in range 0 to 90 degrees

Longitude in range 0 to 180 degrees

If this condition is not satisfied the appropriate bit is set on in the quality control bytes[1].

[Byte 0 bit 0 for surface reports, byte 0 bit 1 for upper air reports].

4. Valid Octant --- 5

A check is made that the value reported is in range 0 to 3 or 5 to 8, otherwise byte 0 bit 0 of the quality control bytes[1] is set on.

5. Valid position for reported OWS call sign --- 5

This check considers all ships with a 'C7' type call sign. The reported position is required to lie within a square of side 210 NM and centred on the 'on-station' position for that call sign.

If this condition is not satisfied the following action is taken:-

(i) Surface reports - byte 0 bit 0 of the quality control bytes[1] is set on.

(ii) Upper air reports - the call sign is replaced by 'SHIP' and the Marsden square check subsequently applied (q.v.).

6. Land or sea position --- 5

A check is applied to the reported latitude and longitude to discern whether any sea exists within the one-degree square occupied. If this condition is not satisfied byte 0 bit 0 of the quality control bytes[1] is set on.

7. Marsden square consistent with latitude and longitude --- 5

(i) If the latitude and/or longitude is missing byte 0 bit 1 of the quality control bytes is set on. No further check is possible.

(ii) If the quadrant is missing a value is calculated using the Marsden square value. A substitution is made (see substitution of values) and step (v) then follows.

(iii) The quadrant is examined. If it is not a valid value (ie 1, 3, 5 or 7) a new value is calculated as in (ii) above.

(iv) Values for 'U_{la}' and 'U_{lo}' are determined from the reported latitude ($L_aL_aL_a$) and longitude ($L_oL_oL_oL_o$). If these differ from the actual reported values of U_{la} and U_{lo} substitutions are made for the reported values (see substitution of values).

(v) A Marsden square value is calculated from the given values of latitude, longitude and quadrant. If the calculated value differs from the reported value the following action is taken.

(a) 'C7' type call sign - calculated Marsden square value is substituted for the reported value (see substitution of values). It is acceptable to make this substitution following the check described in para 5.

(b) Other call signs, 'SHIP' or SIRS - no substitution is made but byte 0 bit 1 of the quality control bytes[1] is set on.

8. Duplicate reports within one-degree square --- 5

The practice in some centres is to 'round' the latitude and longitude of upper air ship reports to the nearest half degree. In consequence two otherwise identical reports may be received but one is 'rounded' whilst the other is not.

In order to avoid this a check is made that both the latitudes and longitudes of any two reports are different by more than one degree. If not the two reports are then checked to see if they are otherwise identical, in which case only the first report received is stored. If they are not identical they are flagged as duplicates with differences, byte 6 bit 0[1] of the first report being set on.

NOTE

In preparing for the GATE experiment it was realised that several ships would be in close proximity and so special provision was made within this check.

There is therefore a permanent test in the Quality Control suite for ship reports emanating from a zone 30°N to 30°S and the following rules are applied to such reports:-

(i) Two positions ≤ 1 deg different, same call sign (not SHIP) - treated as duplicates.

(ii) Two positions ≤ 1 deg different, different call signs - treated as separate reports.

(iii) Two positions ≤ 1 deg different, both call sign 'SHIP'

1. latitudes and longitudes identical - treated as duplicates
2. latitudes and longitudes not identical - treated as separate reports.

9. Position consistent with reported movement --- 4

This check considers the current report in relation to the report made:-

(i) 3 hours previously for an OWS.

(ii) 6 hours previoiusly for any other ship report (or for an OWS where (i) is not available).

If the previous report position has been flagged this check is abandonned.

The formulae used are shown at A in Appendix I. If the conditions are not satisfied bits are set on for

(i) the position - byte 0 bit 0 of the Q/C bytes[1]

(ii) Ds Vs - byte 2 bit 0 of the Q/C bytes[1].

An indication that the appropriate previous report was found and the check completed is byte 6 bit 4 of the current report[1] set on.

NOTE

It is not indicated which previous report was used, in the case of an OWS. (ie 3 hours or 6 hours previous). Also, in the event of the previous report (or reports) being queried for position, this check will not be carried out, nor will the pressure-tendency sequence check (No. 14).

10. Internal consistency of elements --- 5

If any of the following conditions exist the appropriate bit in the quality control bytes[1] is set on to indicate inconsistency within the report. The symbols used here are those used in WMO No. 306 Manual on Codes.

(i) N

$N = 9$ and $N_s \neq 9$

$N \neq 9$ and $N_s = 9$

$N = 0$ and $N_h \neq 0$

$N \neq 0$ and $N_h = 0$ and $h \neq 9$

$N = 9$ and $C_L \neq /$, $C_M \neq /$, $C_H \neq /$

$N = 0$ and $C_L \neq 0$

$N = 0$ and $C_M \neq 0$

$N = 0$ and $C_H \neq 0$

$N = 8$ and $N_h < 8$ but $C_M = C_H = /$

$N > 0$ but $C_L = C_M = C_H = 0$

$N < N_h$

$N < N_s$

$N = 9$ and $VV \geqq 10$

$N = 0$ but '8' group(s) reported

$N = 0$ and $h \neq 9$

$N = 0$ and ww = 03, 14 to 17, 50 to 75, 77 to 99

$N \neq 9$ and ww = 43, 45, 47 or 49

$N = 9$ and ww = 00 to 29, 40, 42, 44, 46 or 48

(ii) dd

$99 > dd > 36$

$dd = 99$ and $ff \geqq 06$

$dd = 00$ and $ff \neq 00$

$dd \neq 00$ and $ff = 00$

$ff \geqq 70$ kt. and no '9' group of form:- 909--, 910--, 911--, 912--

(iii) VV

VV = 00 to 09 and ww ≠ 04, 30 to 39, 41 to 49, 54 to 59 73 to 78, 84 to 89, or 97 to 99

VV > 09 and ww = 41 to 49

VV ≧ 20 and ww = 74 to 75

VV ≧ 90 when a land report

VV = 51 to 55

(iv) ww

ww = 00, N ≠ 0 and 8 group(s) reported

ww = 07 and ff ≦ 10

ww = 43, 45, 47 or 49 and N and/or $N_h \neq 9$

ww = 24, 48, 49, 56, 57, 66 to 79 or 83 to 88 and TT ≧ 05

(v) TT

$TT < T_dT_d$

$TT \neq T_dT_d$ and ww = 42 to 49

(vi) N_h

$N_h = 0$ and C_L or $C_M \neq 0$

$N_h \neq 9$ and $C_L = /$

$N_h = 0$ and $h \neq 9$

$N_h \neq 9$ and $C = /$

$N_h = 8$ and $C_H \neq /$

$N_h = 8$, $C_L = 1$ to 9, and $C_M \neq /$

(vii) C_L

$C_L = 0$ and '8' group(s) given whose $C \geqq 6$

$C_L = 1$ to 9 and C of first '8' group $\neq 6$ to 9

$C_L = C_M = 0$ and $N_h \neq 0$

$C_L \neq 0$ and $N_h = 0$

$C_L = 3$ or 9 and no $C = 9$ if any '8' group(s) reported

$C_L = /$ and C_M and $C_H \neq /$

$C_L = C_H = 0$ and $N \neq N_h$

(viii) h

h = / and N or $N_h \neq 9$

(ix) C_M

$C_M = /$ and $C_H = 0$ to 9

$C_M = C_L = 0$ and '8' group(s) given whose $C \geqq 3$

$C_M = 0$ or / and C of relevant 8 group = 3 to 5

$C_M = 1$ to 9, $C_L = 0$ and C of first 8 group $\neq 3$ to 5

$C_M = C_H = 0$ and $N \neq N_h$

(x) C_H

$C_H = C_M = C_L = 0$ and '8' groups given

$C_H = 0$ or / and C of relevant 8 group = 0 to 2

$C_H = 7$ and $N \neq 8$

$C_H = 1$ to 9, $C_L = C_M = 0$ and C of first 8 group $\neq 0$ to 2

$C_H = 0$ to 4 and $C \neq 0$ in relevant 8 group

$C_H = 5$ to 8 and $C \neq 2$ in relevant 8 group

$C_H = 9$ and $C \neq 1$ in relevant 8 group

(xi) N_s

$N_s = 0$ in any 8 group

$N_s = 9$ and $C_L \neq /$

$N_s = 9$ and $C_M \neq /$

$N_s = 9$ and $C_H \neq /$

$N_s \neq 9$ and $N_h = 9$

$N_s = 9$ and $N_h \neq 9$

N_s of second 8 group $\leqq 2$ and $C \neq 9$

N_s of second 8 group = 9

N_s of third 8 group $\leqq 4$ and $C \neq 9$

N_s of third 8 group = 9

(xii) C

$C = 0$ to 2 and $C_H = 0$ or /

$C = 3$ to 5 and $C_M = 0$ or /

$C = 6$ to 8 and $C_L = 0$ or /

$C = 9$ and $C_L \neq 3$ or 9

C = / in second, third or fourth 8 groups

$C = 6$ to 9 in any 8 groups and $N_h < N_s$

(xiii) h_sh_s

First 8 group $h_sh_s = 59$ to 89 and $C_L \neq 0$

First 8 group $h_sh_s = 71$ to 89 and $C_M \neq 0$

First 8 group $h_sh_s = 59$ to 67 and $C_M = 0$

First 8 group $h_sh_s = 59$ to 67 and $C \neq 3$ or 4

First 8 group $h_sh_s = 67$ to 71 and $C \neq 0$ to 5

First 8 group $h_sh_s = 71$ to 89 and $N_h \neq 0$

First 8 group $h_sh_s \geqq 90$

First 8 group $h_sh_s = 51$ to 55

First 8 group $h_sh_s = 67$ to 70 and C_M and $C_H = 0$

First 8 group $h_sh_s = 71$ to 89 and $C_H = 0$ or $C \neq 0$ to 2

First 8 group h_sh_s not consistent with h

Two 8 groups whose h_sh_s values are equal and neither $C = 9$

(xiv) W1W2 are compared against each other.

11. Background field pressure comparison --- 5

This check follows that in para 11 and so the pressure value has by now been set up in full form i.e. with the hundreds digit(s) in place.

The check is applied when:-

(i) a background field pressure value is available,

(ii) the time of the report is 00Z or 12Z,

and (iii) it is a ship report, or it is a land report in which $200 < PPP \leqq 800$ (for PPP see para 11).

If the pressure reported is not within $\pm$ 30 mb[3] of the background field value appropriate to the data bank, bit 0 byte 1 of the quality control bytes[1] is set on.

12. Tropical Pressure Limits --- 4

This check considers pressure values reported in tropical latitudes.

Ship reports contain latitude within the report. The latitude of land reports is obtained from a station index. The precise latitude bound within which reports are checked is 30 deg N to 30 deg S.

The reported pressure is required to lie within the extreme pressure values determined by B in Appendix I. If this is not so bit 0 byte 1 of the quality control bytes[1] is set on.

13. Pressure-tendency sequence (over 3 or 6 hour period)

This check makes reference to the report made 3 hours previously if a land report (SYNOP) or an OWS is being considered. If however no report is available for 3 hours before or no pressure value has been reported in it or the pressure value is reported but has been flagged, reference is made to the report received 6 hours previously.

For all ship reports other than OWS, only a 6 hour check is applied.

The following conditions require to be satisfied:-

3 hour check (SYNOPS and OWS)

$$|T_L - (P_L - P_E)| \leqq 2 \text{ mb} \quad --- \quad 3$$

6 hour check

$$|K - (P_L - P_E)| \leqq 5 \text{ mb} \quad --- \quad 3$$

where T = Pressure tendency (+ ve or - ve)

P = Reported pressure

L = Present report

E = Previous report

$K = {}^1/_2\, T_E + {}^3/_2\, T_L$

If the condition is not satisfied bit 0 byte 1 and bit 2 byte 2 of the quality control bytes[1] are set on.

If the condition is satisfied, bit 0 byte 1 and bit 2 byte 2 of the quality control bytes[1] are unset, thus providing a correction for any queries, which may have arisen from the somewhat coarser background field pressure check.

If this check is completed bit 4 byte 6 of the report[1] is set on.

14. Temperature - dew point check

In all cases a check on the reported dew point follows, making use of what has been learned in the previous step and bearing in mind that the dew poitn should be not greater than the temperature. If the conditions for extreme dew point are satisfied bit 4 byte 8 of the report [1] is set on.

Dew point depression is then considered and must not exceed 50°C, otherwise bit 1 byte 1 and bit 7 byte 1 are set on in the quality control bytes[1].

For ship reports a basic consistency check is applied. The dew point depression must not exceed 30°C, but the dew point may exceed the air temperature by up to 1°C.

15. <u>850 mb and 700 mb Thousands Digit</u> --- 4

When coded in the report the thousands digit is omitted from the 850 mb and 700 mb heights. It is necessary to restore this before the appropriate values are used.

In the first instance it is assumed that the appropriate digit for 850 mb is '1' and for 700 mb is '2'.

This 850 mb height is accepted as correct unless a 500 mb height is available which is ≦ 5100 m and the 850 mb height is >1650 m. In the latter case the 850 mb height is reset with a '0' digit in the thousands place and bit 0 byte 8 of the report[1] is set on.

This 700 mb height is accepted as correct unless the value obtained is ≦2300 m in which case the digit is replaced by '3' and bit 0 byte 8 is set on.

16. <u>Maximum Permitted Wind Speed for Each Standard Pressure Level</u> --- 4

This check is preceded by a valid direction check. Acceptable directions are '99' and 0 to 360 degs, otherwise the bit in the quality control bytes[1] for that wind is set on.

The table of maximum speeds is in Appendix I, D.

A level with wind speed in excess of the permitted maximum has the appropriate bit in the quality control bytes[1] set on.

17. <u>Wind Shear Check</u> --- 4

If f_1 and f_2 are the wind speeds in knots at two consecutive standard levels, the maximum speed shear $|f_1 - f_2|$ permitted is

$$40 + 0.275\ (f_1 + f_2).$$

If this condition is not satisfied the bit in the quality control bytes[1] is set on for the levels concerned in the shear check and the check is complete.

At this point if the two levels being considered are not adjacent, because of a missing level between them, the check terminates.

The directional shear D_s is $|d_2 - d_1|$ where 'd' represents the wind direction in degrees. If $D_s > 180$ deg, then $(360 - D_s)$ is used; if $D_s < 30$ deg the check terminates.

The maximum permitted $|f_1 + f_2|$ for the D_s found is obtained from the table in Appendix I at E. If this maximum is exceeded the bit in the quality control bytes[1] is set on for the levels concerned in the shear check.

18. The hydrostatic check --- 4

The hydrostatic check can be summarized only with difficulty. The formulae used are to be found in Appendix II where the terms are defined also. References are to Appendix II.

The procedure is as follows:-

(i) The thickness error for each layer between adjacent standard levels is calculated in turn. This error is the difference between the thickness computed (see equation (1)) and the thickness reported.

(ii) If there are no errors >55 m the check is complete up to item (vii).

(iii) Errors often occur as a result of the wrong sign of the temperature being given. An attempt is made to remove such errors by reversing the sign of the temperature if it is known to be a temperature error (signs of successive errors the same). Replacements are made in the report if errors are thus resolved, bit 1 byte 6 of the report[1] being set on.

(iv) Errors remaining. A Criterion is calculated based on lapse rate considerations and the reported temperatures at the levels concerned (see equation (2)). If this criterion is not already ≧20 m it is replaced by 20. At this point if it is a boundary layer the procedure is as step (vi) et seq. Otherwise and only if the thickness error is greater than the criterion, further checking continues at (v).

An additional check is to see if the 700 mb or 850 mb levels have been reported in decametres. If error then <30 m, a substitution is made. All temperature values at or above 400 mb are checked and the sign changed if they are positive. A check for reversed digits is also made if an error is detected.

(v) By reference to the magnitude and sign of the thickness errors in the adjacent layers, it is decided on which side of the layer the error exists and which is the offending value (signs the same - a temperature error, signs opposite - a height error). A mean value of height or temperature is computed from the adjacent two layers as appropriate and a new thickness error and new criterion (if it was a temperature error) obtained.

Then one of the following courses of action follows:-

New error $\leqslant$ old error

(a) New error $\leqq$ criterion - use new value of height or temperature to replace that reported. Bit 1 byte 6 of the report[1] is set on.

(b) New error > criterion - all levels from the offending level upwards (heights and temperatures) are set on in the quality control bytes and bit 2 byte 6 of the report is set on. (Error must be at the source, not in transmission).

New error > old error

(a) Old error < 30 m - accept reported values.

(b) Old error $\geqq$ 30 m - errors in adjacent layers <20 m - adjust offending level and all levels upwards by the amount of the old error. These values replace the reported values and bit 1 byte 6 of the report[1] is set on.

Errors in adjacent layers $\leqq$20 m - all levels from the offending level upwards (heights and temperatures) are set on in the quality control bytes and bit 2 byte 6 of the report[1] is set on.

(vi) Boundary layer - thickness error $\geqq$20 m.

A boundary criterion is formed (see equation (3)) but the value used for this is the minimum of that calculated, the criterion produced in step (iv) and 20 m. If the thickness error for the layer is not greater than the boundary criterion the reported values are accepted. Otherwise it is decided which value is at fault by comparing the signs of the thickness errors in the boundary layer and the adjacent layer (signs the same - a temperature error, signs opposite - a height error).

A replacement value is computed as a mean of those derived from the adjacent layers and a new thickness error for the layer and a new criterion (if it was a temperature error) are calculated. One of the following courses of action follows:-

a) <u>New error ≦ old error</u>

1. New error < boundary criterion - if a lower boundary, and the adjacent layer error was originally < 20 m, the bits in the quality control bytes[1] are set on for the lower level of the boundary layer (height and temperature), otherwise the new value of height or temperature is used to replace the reported value, bit 1 byte 6 of the report[1] is set on.

2. New error ≧ boundary criterion -

(i) Criterion < 0

- lower boundary and error <0 - upper boundary and error >0	bits are set on in the quality control bytes[1] for height and tmeperature of the level at fault.
- lower boundary and error >0 - upper boundary and error <0	a new temperature, a new error and then a new criterion are calculated. If this error is not greater than the criterion proceed as 1 above. Otherwise the bits in the quality control bytes[1] are set on for the offending level <u>unless</u> it is 1000 mb when reference is made to the forecast Background Field value for that time. A height for 1000 mb is calculated from the 850 mb values and if this height is closer to the

BGF value than the reported value, a replacement is made with this computed height, bit 1 byte 6 of the report[1] being set on. Otherwise the bits in the quality control bytes[1] for 1000 mb height and temperature are set on.

(ii) Criterion ≧0 - the bits in the quality control bytes[1] for the boundary level are set on, bit 2 byte 6 of the report[1] is set on, unless it is a 1000 mb level, when reference is made to the forecast background field value as in the immediately preceding step.

b) New error > old error - as for step 'criterion ≧0' above.

(vii) Having completed all of the preceding steps applicable to the report, the lower boundary is considered more fully. If the report commences at a lower pressure value than 850 mb or the 1000 mb and 850 mb levels are queried (bits set on in quality control bytes for those levels) next step is (ix).

850 mb level

No height reported - no action.

No temperature reported - if 700 mb values are available and not queried an estimated 850 mb temperature is obtained by adding '7' to the 700 mb temperature. Using the 700 mb values and this estimated 850 mb temperature a height is calculated for 850 mb and a thickness error produced. The thickness error is required to be <40 m, otherwise the bit in the quality control bytes[1] for 850 mb (height) are set on.

- if 700 mb values are queried or not available the bit in the quality control bytes[1] for 850 mb is set on.

1000 mb level

No height reported	-	no action.
No temperature reported (or received corrupt)	-	if 850 mb values are available and not queried an estimated temperature for 1000 mb is obtained by adding 6 deg to the 850 mb temperature. Using 850 mb values and this estimated 1000 mb temperature, a height is calculated for 1000 mb and a thickness error produced. The thickness error is required to be less than 40 m. If not and the computed 1000 mb height is closer to the forecast background field value, the reported height is replaced by the computer height and bit 1 byte 6 in the report[1] is set on. Otherwise the bit in the quality control bytes[1] for 1000 mb is set on and bit 2 byte 6 of the report is set on.
	-	no 850 mb values available but 700 mb values available. An estimated 1000 mb temperature is obtained by adding 13 deg to the 700 mb temperature. The procedure to check the reported 1000 mb height is then as in the preceding check.
	-	neither 850 mb nor 700 mb values available. The bit in the quality control bytes[1] for 1000 mb is set on and bit 2 byte 6 in the report[1] is set on.

(viii) If a complete set of values is available for 1000 mb and surface values are also available, a thickness error for the layer surface to 1000 mb is obtained. If this error is not less than 20 m, reference is made to the forecast background field value for 1000 mb (BGF). Then, if the computed height is closer to the BGF value than the reported value, the reported height is replaced by the computed value, bit 1 byte 6 of the report being set on. Failing this check the bits for the 1000 mb level are set on (height and temperature).

(ix) Isolated levels (except 1000 mb checked out satisfactorily in step (viii)) are set on in the quality control bytes[1] (height and temperature) as they cannot be checked hydrostatically. Similarly isolated values (except 1000 mb and 850 mb heights checked out in step (vii)) are set on in the quality control bytes[1] (eg height bit is set on, if no temperature; temperature bit is set on if no height). Bit 2 byte 6 is then set on.

(x) Superadiabatic check (see equation 4). If the lapse rate of a layer is superadiabatic, the bits reprsenting height and temperature at the top and bottom of the layer are set on in the quality control bytes, bit 2 byte 6 is also set on.

APPENDIX I

A. (i) $$\left|\left[17\cdot3\left\{V_E\left(\frac{t}{6}-\frac{1}{2}\right)+V_L\left(\frac{t}{6}+\frac{1}{2}\right)\right\}-2\cdot3t\right]-3960\left\{0\cdot017453\sqrt{(\phi_L-\phi_E)^2+(\theta_L-\theta_E)^2\cos^2\phi_L}\right\}\right|$$

<100 statute miles - - - (4)

factor 17.3 comprises a nautical miles, to statute miles converson, 1.153, a time interval factor of 3, and a code converted = 5.

2.3 represents code conversion, nautical miles to statue miles conversion and a time interval factor.

3960 is radius earth in statute miles.

0.017453 is degrees to radians conversion.

If no V_E reported, $V_E = V_L$. If no V_L then distance moved is computed from the reported positions:-

(ii) <200 statute miles - - -(4)

where V = ships velocity code

t = time interval

E = previous value

L = current value

Ø = latitude

θ = longitude

B (i) Land reports - reported pressure should lie in range

$1020 + 125 (\sin Ø)^2$

and $995 - 125 (\sin Ø)^2$ - - - - - - - - - - - - 4

(ii) Ship reports - reported pressure should lie in range

$1020 + 125 (\sin Ø)^2$

and $995 - 125 (\sin Ø)^2$ - - - - - - - - - - - - 4

Note: These ranges are modified three level model checks. The significance of two distinct checks is not known, but at 30° latitude which is the greatest latitude of the check, the extremes are 2.5 mb greater for ships than for land reports.

C (i) Cold WMO blocks - Temperature <-50°C acceptable:

01, 02, 04, 20 to 39 inclusive, 46, 70 to 74 inclusive, 85, 88, 89, 94.

Hot WMO blocks - Temperature >50°C acceptable:

40 to 46 inclusive, 60 to 67 inclusive, 72 to 76 inclusive, 94.

(ii) Cold months - Northern hemisphere - Temperature <-50°C acceptable:

January, February, March, November, December.

Hot months - Northern hemisphere - Temperature ≥50°C acceptable:

April, May, June, July, August.

APPENDIX II

1. Thickness of layer - level n to level (n + 1)

Thickness = $\frac{R}{2g}\left[\log_e P_n - \log_e P_{(n+1)}\right].\left[T_n + T_{(n+1)}\right]$ - - - - - - 3

2. Criterion = $0.8\left[A_n.T_n + B_n.T_{(n+1)}\right]$ - - - - - - 3

3. Boundary Criterion = $\frac{15R}{2g}\left[\log_e P_n - \log_e P_{(n+1)}\right]$ - - - - - - 3

used to avoid excessive criteria from temperature errors.

4. Superadiabatic check requires the following condition to be satisfied:-

$$\left[\left(\frac{2B_n g}{C_p}+1\right)T_{(n+1)} - T_n\right] \ngtr C$$ - - - - - - 3

CONSTANTS

R	=	287.05	B_n	=	$\frac{C_p}{2g}\left[\left(\frac{P_n}{P_{(n+1)}}\right)^K - 1\right]$
g	=	9.81			
P	=	Pressure in mb	C_p	=	1000
n, n + 1	=	Refer to successive levels	K	=	$\frac{R}{C_p}$
T	=	Temperature in °K	C	=	-2°K, but for 1000-850 mb layer it is -4°K
An	=	$\frac{C_p}{2g}\left[\left(\frac{P_{(n+1)}}{P_n}\right)^K - 1\right]$			

NOTE: The temperature value used in equations 1, 2 and 3 above is Virtual temperature when a dew point is reported which is not less than 258°K.

Hot months - Southern hemisphere - Temperature ≥50°C acceptable:
January, February, October, November, December.

Note: In the Southern hemisphere, a month which does not appear as a 'hot month' is treated as a 'cold month'.

D Permitted maximum speed, where PPP represents the pressure of the level being considered, H represents the height in metres of the level being considered.

Pressure Value	Height	Maximum Permitted Speed (kt)
PPP ≧1000 mb	300 m ≧ H	70
1000 mb > PPP ≧ 850 mb	1500 m ≧ H > 300 m	90
850 mb > PPP ≧ 700 mb	3000 m ≧ H > 1500 m	120
700 mb > PPP ≧ 500 mb	5500 m ≧ H > 3000 m	200
500 mb > PPP ≧ 400 mb	7000 m ≧ H > 5500 m	250
400 mb > PPP ≧ 300 mb	9000 m ≧ H > 7000 m	300
300 mb > PPP ≧ 250 mb	10500 m ≧ H > 9000 m	300
250 mb > PPP ≧ 200 mb	12000 m ≧ H > 10500 m	300
200 mb > PPP ≧ 150 mb	13500 m ≧ H > 12000 m	200
150 mb > PPP ≧ 100 mb	16000 m ≧ H > 13500 m	200
100 mb > PPP	H > 16000 m	200

E Maximum permitted (f_1 + f_2) in kts related to levels and D_s (the directional shear).

Levels	D_s in deg ≧30	≧40	≧50	≧60	≧70	≧80	≧90
1000-850 mb 850-700 mb 150-100 mb Layers ≦100 mb in pressure value	140	118	110	103	95	88	80
Other layers	210	162	149	136	122	100	96

APPENDIX III

UPPER AIR QUALITY CONTROL

Quality control on complete ascents was confined until recently to Temp Part A's (standard levels up to 100 mb) because (a) only those levels were used in forecasts and (b) the 4 parts of an ascent (standard and significant levels, below and above 100 mb) are not received together, so that quality control of complete ascents must be done when the data is used rather than on receipt.

If standard and significant levels are both available, two kinds of tests are possible in addition to those that can be done on any level (eg checks against climatological extremes) or any sequence of levels (eg crude lapse rate checks):

a. interpolation of standard level values from significant points, which should agree (by WMO criteria) to within 1° for temperature.

b. a hydrostatic check more accurate than can be done on standard levels alone.

The checking procedure moves from the crudest checks to the final hydrostatic check, trying to eliminate the more obviously wrong values before they make adjacent values suspect. When all available data (standard and significant levels, tropopauses and max winds) have been put in order, the sequence of tests for temperature and height is as follows:

1. Check temperatures against climatological extremes.
2. Check surface temperatures in parts A and B one against the other (and, if they are different, against the background field given by the forecast).
3. Check surface level (with station height) hydrostatically against the nearest standard level. The height given by the WMO station index is known to be wrong for many stations; suspect station heights will not be used in later calculations.
4. Check lapse rate layer by layer. Working upwards, check each temperature against the level below; flag any temperature that gives an excessive lapse rate (superadiabatic or inversion) and exclude it from the next step up.
5. Interpolate temperatures at standard levels from significant levels above and below (interpolating in log p). The reported temperatures should be within 2°C at or below the 300 mb level or

within 4°C above that level. If not, one of the three is suspect; tests on adjacent layers _may_ decide which - but not always, because there may be _several_ significant levels between two standard levels, in which case there is no check on an adjacent layer. (So this test will not always check _every_ significant temperature).

6. Check dew points by interpolating dew point depressions. These should be such that relative humidity can be interpolated to within 15%.

7. Virtual temperatures can now be calculated (assuming RH=0 at levels with suspect dew points) and then heights at significant levels, from the surface upwards (leaving out significant points with suspect temperatures).

8. Now calculate each standard height from the significant level below, flagging any reported height that differs from the calculated value by more than 50 m (or by height/250, if this is greater, which is a rough estimate of the height error implied by a 1° temperature error throughout the ascent).

For winds, tests 1 and 5 can be done, and a shear check on winds at adjacent levels.

For pilots, test 5 can only be done roughly, by assigning to standard levels the conventional heights agreed for each region.

The flagging is not simply acceptable/suspect, because flags are also set to show whether the interpolation and hydrostatic checks were done; so it could be interpreted as follows:

Error flag	Test flag	
off	on	supported by adjacent values
off	off	acceptable, but only crude checks done
on	on	there is a wrong value - but may be not this one, if adjacent values are flagged too
on	off	crude error

For details of tests (formulae and tolerances) see SDB Technical Note 12.

(i) Valid date and time check - see para 1.

(ii) Marsden square, U_{la}, U_{lo}, Q_c - see para 6.

(iii) Hydrostatic check - see para 20.

(iv) Pressure level indicator - in TEMP A and TEMP C reports a standard pressure level indicator mis-reported or received corrupt is correctly replaced provided the next standard pressure level indicator can be recognised.

eg TEMP A 70031 ----- ----- 05561 ----- ----- 40714 -----

etc, In this case '05' would be replaced by '50'.

(v) Within PILOT A and PILOT C reports a check is made on 'n' within the '44' or '55' group. If this does not agree with the number of wind values following, a replacement for 'n' is made.

(vi) Within TEMP B and TEMP D reports a check is made on the special point number. If the number is not in sequence or is incorrect a correction is made provided that the next special point number is otherwise in the correct sequence.

(vii) At the report 'handling' stage a letter to figure conversion is made if a letter is reported where a figure is to be expected. No indication of a substitution is made in this case.