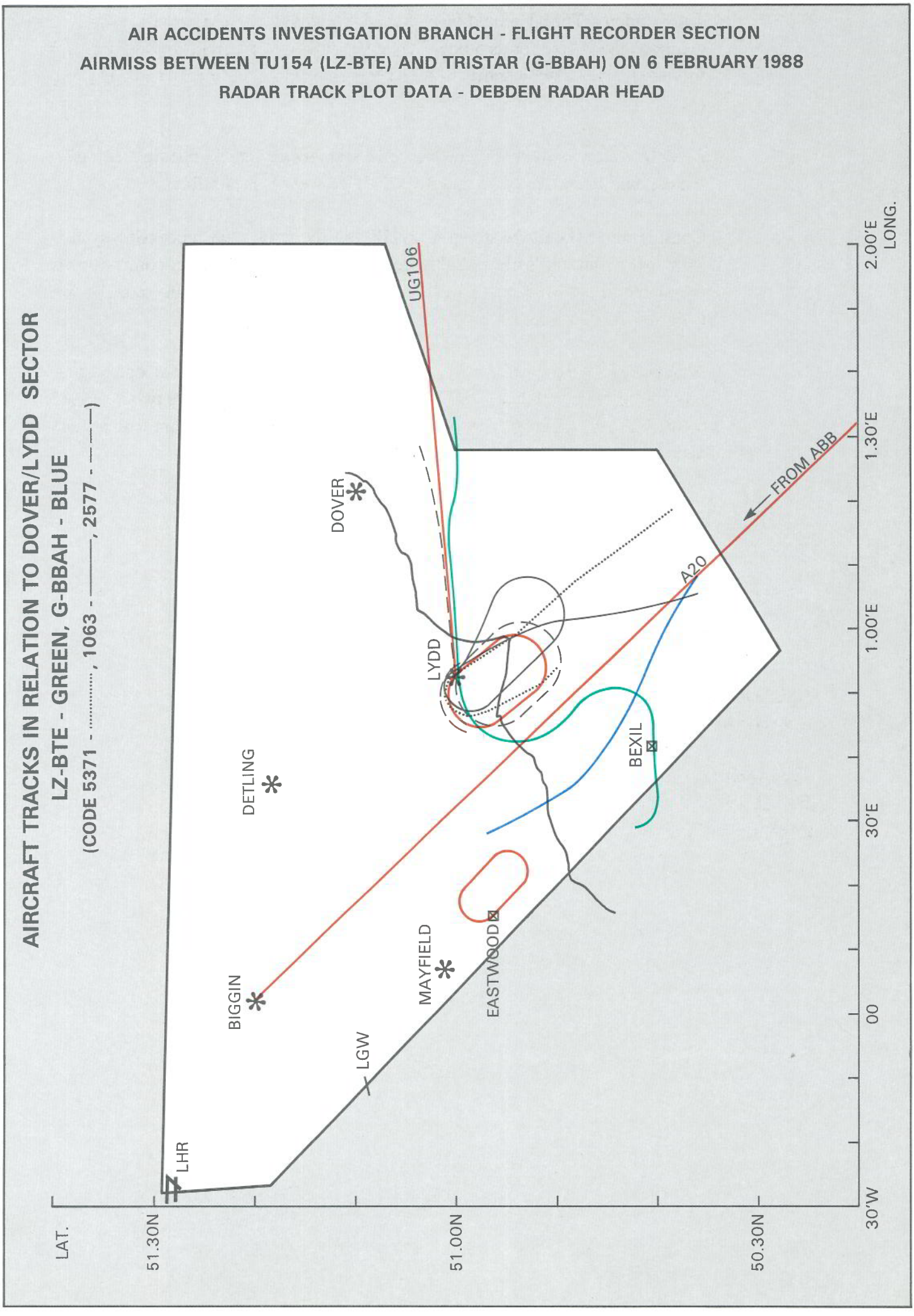
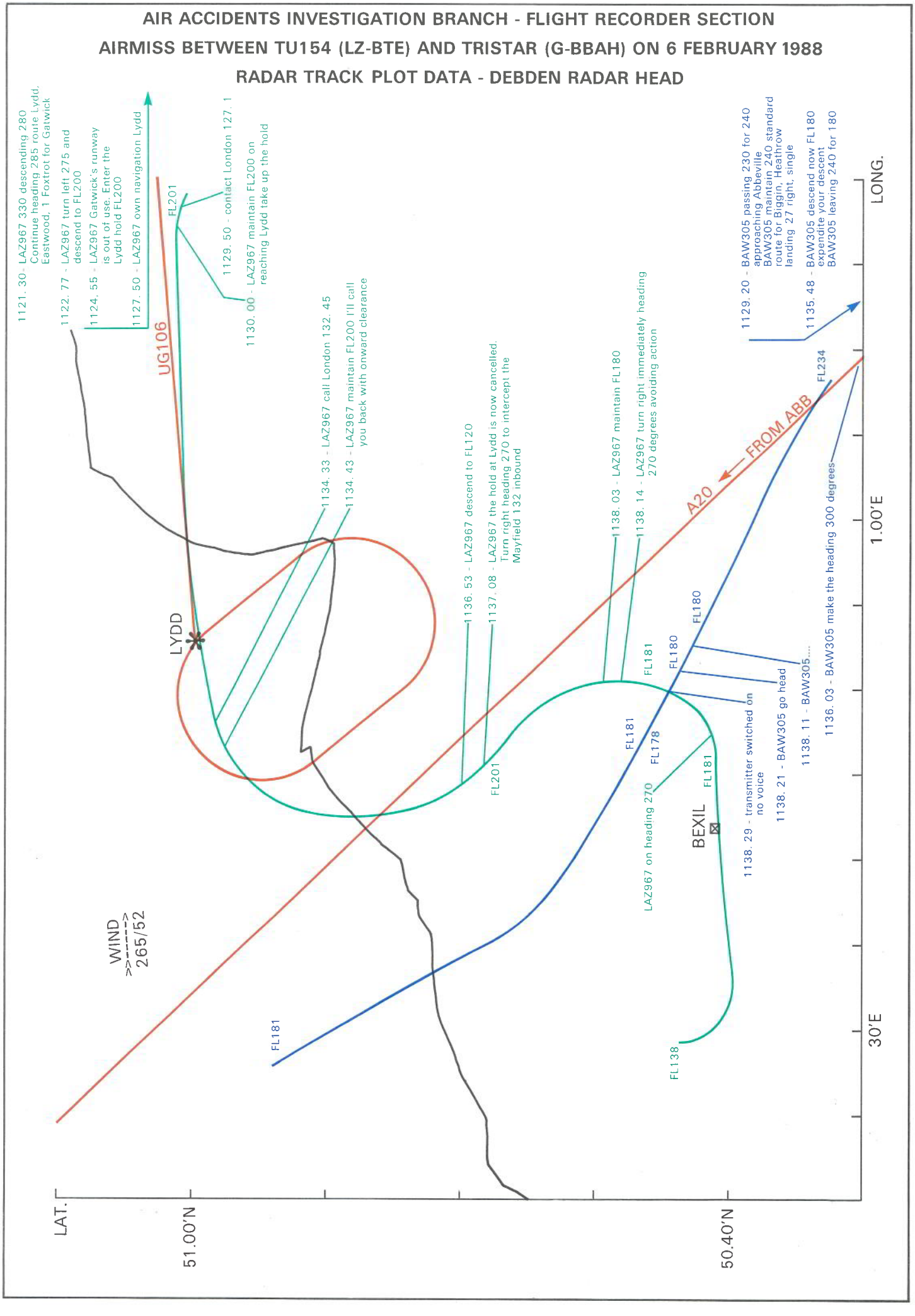
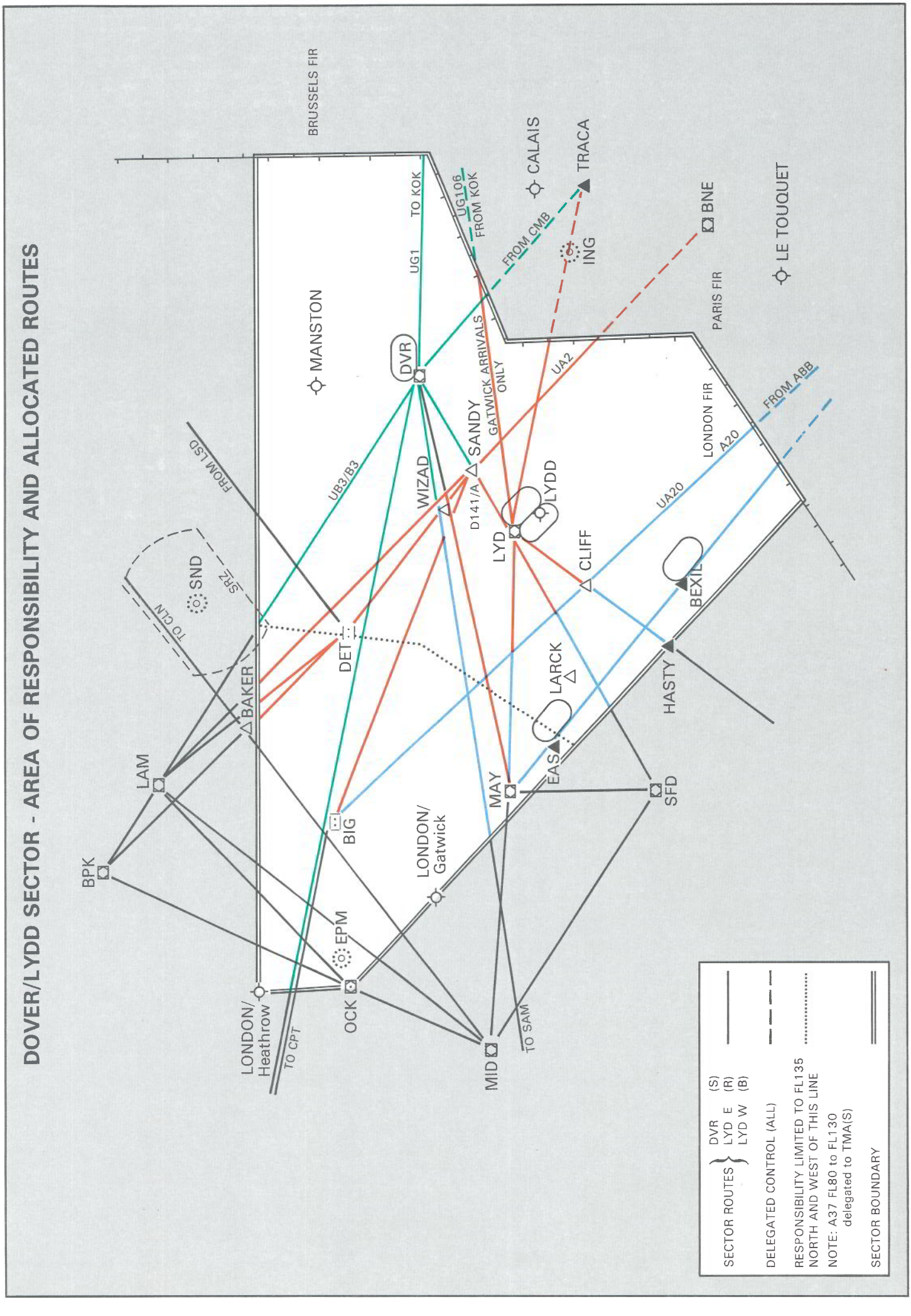
AIR ACCIDENTS INVESTIGATION BRANCH - FLIGHT RECORDER SECTION

AIRMISS BETWEEN TU154 (LZ-BTE) AND TRISTAR (G-BBAH) ON 6 FEBRUARY 1988

RADAR TRACK PLOT DATA - DEBDEN RADAR HEAD




AIR ACCIDENTS INVESTIGATION BRANCH - FLIGHT RECORDER SECTION
AIRMISS BETWEEN TU154 (LZ-BTE) AND TRISTAR (G-BBAH) ON 6 FEBRUARY 1988
RADAR TRACK PLOT DATA - DEBDEN RADAR HEAD
1121. 30 - LAZ967 330 descending 280 Continue heading 285 route Lydd, Eastwood, 1 Foxtrot for Gatwick
1122. 77 - LAZ967 turn left 275 and descend to FL200
1124. 55 - LAZ967 Gatwick's runway is out of use. Enter the Lydd hold FL200
1127. 50 - LAZ967 own navigation Lydd
UG106
FL201
1129. 50 - contact London 127. 1
1130. 00 - LAZ967 maintain FL200 on reaching Lydd take up the hold
LYDD
1134. 33 - LAZ967 call London 132. 45
1134. 43 - LAZ967 maintain FL200 I'll call you back with onward clearance
1136. 53 - LAZ967 descend to FL120
1137. 08 - LAZ967 the hold at Lydd is now cancelled. Turn right heading 270 to intercept the Mayfield 132 inbound
FL201
1138. 03 - LAZ967 maintain FL180
1138. 14 - LAZ967 turn right immediately heading 270 degrees avoiding action
FL181
FL180
FL180
FL181
FL178
LAZ967 on heading 270
FL181
BEXIL
FL181
1138. 29 - transmitter switched on no voice
1138. 21 - BAW305 go head
1138. 11 - BAW305....
FL138
1129. 20 - BAW305 passing 230 for 240 approaching Abbeville BAW305 maintain 240 standard route for Biggin, Heathrow landing 27 right, single
1135. 48 - BAW305 descend now FL180 expendite your descent BAW305 leaving 240 for 180
1136. 03 - BAW305 make the heading 300 degrees
FL234
A20
FROM ABB
WIND >>-----> 265/52
FL181
LAT.
51.00'N
50.40'N
LONG.
30'E
1.00'E


DOVER/LYDD SECTOR - AREA OF RESPONSIBILITY AND ALLOCATED ROUTES
BRUSSELS FIR
TO KOK
UG1
UG106
FROM KOK
CALAIS
TRACA
FROM CMB
ING
BNE
LE TOUQUET
PARIS FIR
MANSTON
DVR
SANDY
GATWICK ARRIVALS ONLY
UA2
LONDON FIR
FROM ABB
A20
UA20
UB3/B3
WIZAD
D141/A
LYD
LYDD
CLIFF
BEXIL
HASTY
FROM LSD
SND
SRZ
TO CLN
BAKER
DET
LARCK
EAS
SFD
LAM
BPK
BIG
LONDON/ Gatwick
MAY
EPM
OCK
LONDON/ Heathrow
TO CPT
MID
TO SAM
SECTOR ROUTES
DVR (S)
LYD E (R)
LYD W (B)
DELEGATED CONTROL (ALL)
RESPONSIBILITY LIMITED TO FL135 NORTH AND WEST OF THIS LINE
NOTE: A37 FL80 to FL130 delegated to TMA(S)
SECTOR BOUNDARY

THE DOVER/LYDD SECTOR CONTROL SUITE

CSC: CHIEF SECTOR CONTROLLER

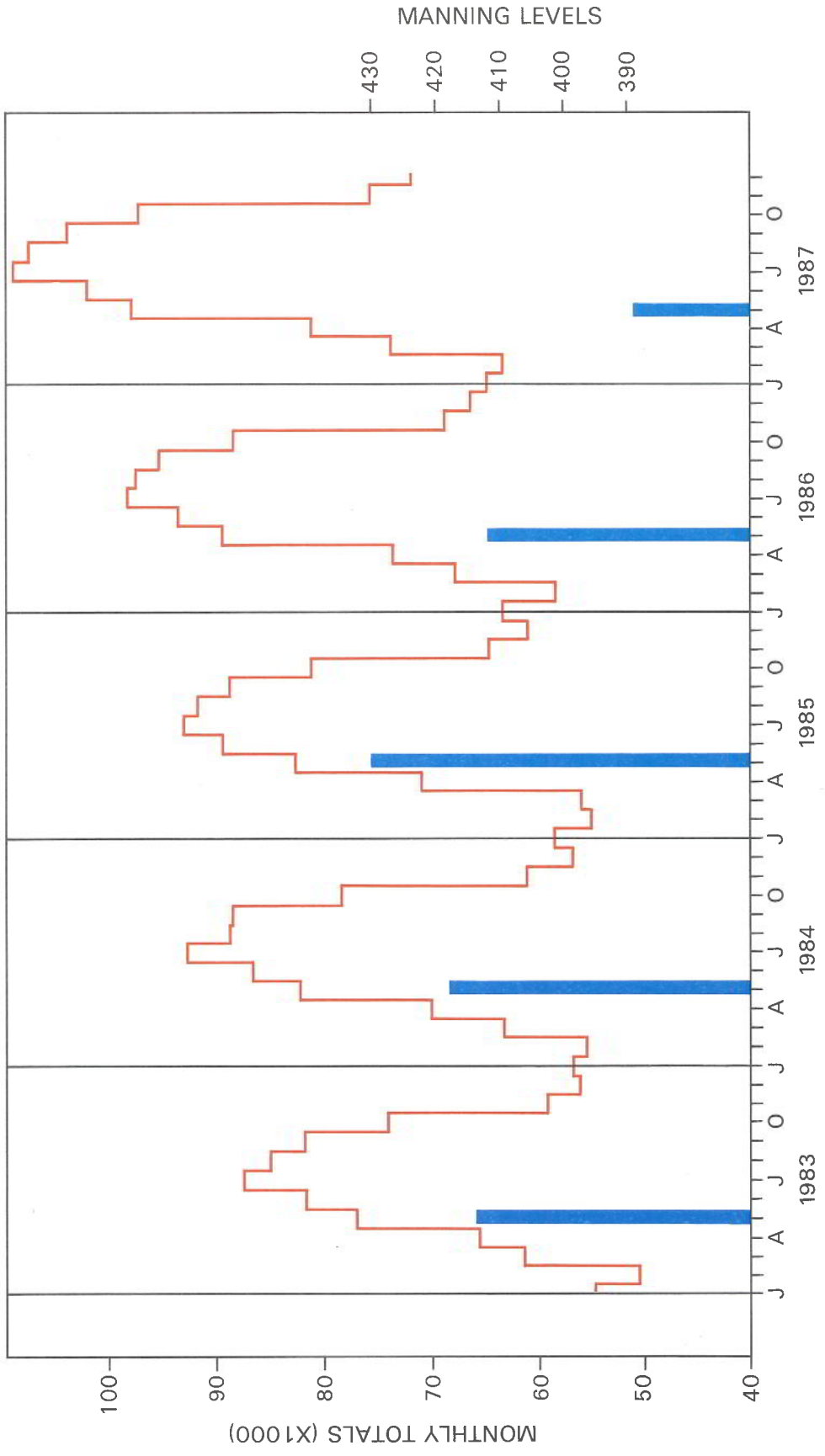
SC: SECTOR CONTROLLER

ASC: ASSISTANT SECTOR CONTROLLER

ATCA: AIR TRAFFIC CONTROL ASSISTANT

AIRCRAFT MOVEMENTS HANDLED BY LATCC 1983-1987

LATCC MANNING LEVELS (ATCOs ONLY) AS AT 1 MAY 1983-1987



DATA ISSUED BY DPA3

LATCC M.I.S.

HUMAN FACTORS ASPECTS

AIR-MISS INCIDENT 6 FEBRUARY 1988

THE REPORT OF THE INSTITUTE OF AVIATION MEDICINE

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I will confine my comments to the Dover-Lydd sector, although I am sure that some at least are as relevant to other sectors in LATCC.

Workload and work practices

Two features of the work on the Dover-Lydd sector console are important to an understanding of the air-miss incident. One is the wide variation in workload which was possible on this sector. The recent introduction of a flow control cell may now restrict the range of variation somewhat. The second factor is the flexibility of work practices on the console. This flexibility enables the controllers to compensate for changes in traffic flow (becoming more efficient as traffic increases, maintaining interest during lulls by taking on other tasks) and allows for differences in experience and skill level.

Table 1 is a break down of functions on the Lydd sector showing the operators most likely to be involved and the mode of information transfer. Many of the activities on the sector are performed, at times, by more than one person. The most flexible functions are those involving liaison with other sectors, particularly Dover sector - which provides an instructive example. From the point of view of the Lydd controller, he may receive information when the Dover controller leans over to annotate a flight strip or when the chief sector controller, having negotiated a solution with the Dover controller and possibly the Lydd or other controllers, annotates a flight strip; in both cases the annotation may be supplemented by verbal or non-verbal communication designed to draw attention to it. In addition to the information sources listed in Table 1, the controllers also have access to the radar display, which presents the current state of affairs, but not the height or heading clearances given to the aircraft.

The flexibility in information transmission just described has important implications. The system could not operate safely at all without considerable in-built redundancy; *ie,* both the sector controller (or controllers, when the sector is split) and the chief sector controller take an interest in coordination with other sectors. Whatever decisions the chief sector controller takes have to be taken into account by the sector controller(s). Equally, the chief sector controller needs to keep abreast of negotiations undertaken by the sector controller(s) as part of his supervision of the sector. At times of low to moderate workload, it is likely that at least two people on the sector are aware of any decision or action taken. The redundancy even extends to other consoles, where controllers with time to spare take an interest in traffic on their radar displays under the control of other sectors. The basic check on a sector controller's activity is, nevertheless, the chief sector controller. However, as workload on a sector increases, the chief sector controller is likely to find more and more of his time taken up with inter-sector coordination. There must come a time when his awareness of the detail of what is happening in the sector is impaired. The flexibility of the system could, to a large extent, conceal such impairment. Indeed, an observer could be unaware of any degradation in supervision until the chief sector controller became totally occupied with inter-sector coordination or other activities, such as briefing for a handover.

Table 1: Organisation of the Lydd Sector

FUNCTION	OPERATOR	MODE
Preparation & modification of flight strips	ASC	pen
Installing active flight strips on the sector controller's display	ASC	physical
Controlling aircraft	SC(E)	RT
Controlling aircraft when the sector is split	SC(E), SC(W)	RT
Liaison between sector controllers	SC(E), SC(W),CSC	pen/voice
Liaison with Dover SC	SC(E), CSC	pen/voice
Liaison with sectors providing traffic inbound to Lydd Sector	CSC, SC(E), SC(W)	telephone
Liaison with sectors accepting traffic outbound from Lydd Sector	CSC, SC(E), SC(W)	telephone/ voice
Supervision and planning	CSC	

ASC : assistant sector controller
SC : sector controller; (E) : East; (W) : West
CSC : chief sector controller

A flexible operating system is advantageous from the operator's point of view because it enables him to exercise some control over his own workload. This is important because a low workload could be just as likely to induce errors as a high workload. The social interactions that take place within and around sector consoles serve a function here: they help maintain arousal near optimum levels when the demands of the job are low. But there are, again, potential drawbacks. At a time of high workload, the intercourse that takes place during a handover, even if kept to the necessary minimum, may prove distracting to an adjacent controller.

There is a special case of inter-controller coordination to consider when the Lydd sector is split between two controllers (Lydd (E) and Lydd (W)). On the day in question, the sector controller (W) relieved the sector controller (E) of responsibility for aircraft in the Lydd hold. There was a clear need for co-operation between these two controllers. That it did not happen was probably due to several considerations already discussed in general terms. The Chief Sector Controller being occupied with negotiations with an adjacent sector was one important factor. Other significant aspects of the failure were:

- The Lydd (E) controller was concerned that an already complex situation would become more demanding when more traffic (already evident on flight strips awaiting activation) entered his sector. His apparent agitation at the prospect was at the root of the decision to split the sector. The distraction of this anxiety over future developments may, in part at least, explain why he did not make a verbal comment to the Lydd (W) controller when he annotated the flight strip of BAW 305 with the clearance to descend to FL180 and turn onto 300°.

- The Lydd (W) controller, having only just taken on the task, was probably not completely settled on the sector when he received the clearance to remove LAZ 965 from the hold. I believe that he probably felt an expeditious removal would be advantageous, and he was able to identify a convenient way of achieving it. Before giving the clearance he checked BAW 305's position and altitude on the radar screen - BAW 305 was still at FL 240 - and he checked the progress of an overflight that might have threatened a conflict (the Chief Sector Controller had specifically drawn attention to this aircraft). Then, having received no verbal indication from the Lydd (E) controller of a change in BAW 305's clearance, he instructed LAZ 965 to turn onto 270° and descend. In essence, the Lydd (W) controller checked two of the three available sources of information about aircraft under the control of Lydd (E), but failed to check the flight strip.

The failure of co-operation between Lydd (E) and Lydd (W) was, therefore, probably due to a combination of factors:

- The distraction caused by the prospect of an imminent build up of traffic in a complex situtation.

- A sense of at least some pressure to expedite exits from the sector.

- The distraction of an overflight at a critical moment.

These were, however, not unusual impositions on the controllers. Although they have a bearing on the incident, I believe that they do not hold the whole explanation. It seems to me that the behaviour of the controllers in this incident was probably not very different from that which might be observed any day on a busy sector. It is the very flexibility of communications between controllers, with the appearance of considerable redundancy in information transfer, that may allow assumptions to go unchecked at times. Such failures could remain unnoticed as a matter of routine and only come to light when dire consequences result. Increasing the redundancy by the technical expedient of adding clearances to the information on the radar display would have reduced the possibility of error in the present case. I am not sure this would necessarily prove a universal palliative given the increase in workload and unavoidable delays in entering the data that it would entail.

The splitting of the Lydd sector entailed a split in executive responsibility. It seems to me that this was not essential. An alternative scheme could involve the Lydd (E) controller retaining the responsibility for all decisions in the sector; when they concerned aircraft on the Lydd (W) frequency, he would have to ask the Lydd (W) controller to make the transmission. The benefit to the Lydd (E) controller of splitting the sector would, under this scheme, seem to be only a marginal reduction in his workload, but this is because the scheme guarantees the necessary coordination between Lydd (E) and Lydd (W). The scheme as used on the day promised a greater reduction in individual workload, but only by ignoring the possibility that greater efficiency might be bought at the expense of inadequate co-operation. Although the alternative I have suggested is probably not a practical one, there may be others that retain the advantages and are more feasible.

Watch supervision

The supervisory chain does not end with the chief sector controller. The watch supervisor and his deputy also have a responsibility to ensure the efficiency and safety of operations on the sector. Several factors mitigate against their close involvement. First, a large part of the deputy watch supervisor's time is taken up

with organisation of the watch staff: scheduling breaking, handovers and movements from one sector to another. This is a necessary task, and one which requires some intelligence. Nevertheless, I believe that the time devoted to it could possibly be reduced by introducing some automation; a cheap microcomputer could run software capable of discharging most of this task, thereby relieving the deputy supervisor for closer involvement with activities on the sector consoles. Second, although the watch supervisors' positions provide a view of most of the sector consoles, and the supervisor is informed about factors affecting traffic flow, his ability to intervene usefully is, I believe, restricted in part by his remoteness from the individual consoles and, in particular, because it is difficult quickly to direct supplementary staff into an overloaded sector. In addition, the introduction of computerised communications between air traffic control centres has probably reduced the time required for an increase in traffic to become apparent. With telephone communications, 10 to 15 minutes warning might be realised; with computer links and automatic flight strip generation, this margin could be reduced considerably. The recent introduction of a separate flow control cell may alleviate this particular problem. I believe, however, that there is still scope for sudden traffic surges if an adjacent centre releases a great part of its hourly allotment in a shorter period. Releasing the deputy watch supervisor from some administrative duties might well improve the contact between the watch supervisor's desk and the sectors. Some improvement in overall control of resources might result, but it is difficult to envisage a major impact on the burden of responsibility currently carried by Chief Sector Controllers.

Display ergonomics

The design of the radar consoles obviously has to meet several conflicting demands, and, as such leaves something to be desired. Its relevance to this particular incident is slender, however, and I can, therefore, confine myself to noting that the Lydd (W) controller's position enjoys only rather awkward access to the radar and flight strip displays. The Lydd (W) controller did indeed find the set up awkward. Additionally, and incidentally, I note that in principle military controllers would have priority in using this position; this could prove extremely embarrassing at times of high workload.

Of more interest is the flight strip display, which, despite the simple technology involved, is a very complex device. The flight strips themselves contain a large amount of printed and written information. In addition, the holders are colour codes for direction of flight. The vertical position of the strips in the display is used in two ways. Generally, strips are arranged in order of estimated time of arrival at a waypoint. Aircraft in a stack may be arranged in order of flight level. Both schemes may be operated simultaneously. The advantages of this system

are obvious. The major disadvantage is that a controller newly installed on the sector, if not adequately briefed, could take some time to become fully aware of all the relationships implied by a particular arrangement of the flight strips. Under pressure of high workload, or when fatigued or distracted, a controller might issue instructions before he had gained a proper appreciation of the situation. Although the Lydd (W) controller had just completed one and a half hours working on the Dover sector when he volunteered to take over Lydd (W), and did receive an economical briefing, I believe that he was not unduly fatigued and that his briefing was adequate.

The working environment

The possibility of distraction during handovers has already been mentioned. The background noise level at LATCC is generally high, partly, I believe, because of the air conditioning system. An additional source of noise and distraction at the time of the incident was work in progress on equipment in the vicinity of the Lydd/Dover console. To the extent that the ambient noise level increases workload by reducing the intelligibility of communications, it may also contribute to fatigue. Obviously this is usually only a minor irritation, and some relief might be found during break periods. Unfortunately, at the times I visited it, the canteen was even noisier than the control room, and I understand that, at the time of the incident, the rest room was no more attractive a prospect.

Stress and training

When the Lydd (E) controller noticed that a collision was possible, he started to make a transmission to the British Airways Tristar, but failed to proceed beyond the callsign. The Lydd (W) controller on becoming aware of the conflict, arrested the descent of LAZ 965 on the assumption that BAW 305 was continuing to descend - a decision that, arguably, made matters worse. The realisation that two aircraft were in jeopardy was almost certainly alarming for both controllers. Both controllers produced unremarkable results in personality tests. Both of their responses to the emergency should be regarded as normal; I do not believe that the majority of controllers could have produced more constructive responses in the circumstances. Could anything be done to improve the response to such emergencies? The only practical counter to the stress of emergencies is training. Not only does it permit the acquisition of relevant skills and responses, it may also allow the trainee to habituate to the stressful aspects of the situation, so that his performance is less likely to be degraded in a real emergency. Clearly an adequate simulation would be complex and expensive. At the moment, however, I believe that controllers receive no off-the-job continuation training or formal periodic competency checks; on-the-job assessment is undertaken on a continuous basis. There may be some value in considering the introduction of periodic

training and checking using simulators so that controllers can be seen to be equipped to deal with a whole range of emergencies and workload conditions. Such a system could, arguably, have been relevant to the causes of the present incident. The Lydd (E) controller was observably agitated at the imminent prospect of a large volume of traffic entering an already complicated sector. This agitation provoked the splitting of the sector and may account for his failure to communicate verbally with the Lydd (W) controller although the Lydd (E) controller's competence to handle the sector was not in doubt it is clear that regular refresher training and checking using a simulator would build confidence both for the controllers and the supervisors, especially if a wide range of demanding conditions were simulated.

Conclusions

Although some sources of distraction and ergonomic problems probably made a contribution to this incident, I believe that the potential for such errors is built in to the system operated at LATCC. A major strength of the system is its flexibility. It is an essential attribute of a system destined to cope with widely varying traffic flows and is a positive influence on the controllers' motivation and morale. I believe it could also obscure impending problems at high workloads and, as a result, favour unsafe modes of failure. Specifically it seems likely that controllers would continue to cope with increasing traffic at the expense of supervision, coordination and cross-checking. Indeed, such coping strategies may become habitual and persist in lower workload conditions. The redundancy of information transmission and Chief Sector Controller checks on Sector Controller activity would become more apparent than real. The present organisational structure (with a watch supervisor and his deputy overseeing all the sectors) does not seem capable of providing adequate back up for a Chief Sector Controller faced with a rapidly developing problem.

Remedies are by no means obvious. Extra support for the Chief Sector Controllers would clearly demand a substantial increase in manpower. The flexibility of operational style is an undoubted advantage. A more rigidly formal system would be intolerant of high traffic rates and would show obvious signs when overloaded; the latter is an advantage as long as the resources exist to respond. A more rigid system would also be likely to have an adverse effect on morale and motivation. At least one technical improvement, the provision of clearance information on the radar display, is possible, but at some as yet unspecifiable cost in the controller's workload. Fortunately, it is not the purpose of this report to propose specific remedies. Nevertheless, I feel bound to record that everyone I spoke to at LATCC in connection with this investigation believed that changes were urgently required, not least because the problem of sudden

increases in traffic flow seems set to give way to that of sustained high traffic rates.

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