

ATC TRANSCRIPT

Doubtful words are indicated by a series of question marks. The time signal is shown in brackets as it occurs in the sequence. There was a slight difference between the time signals at LATCC and Southampton (SOTON) but it was of no significance and has not been adjusted.

The co-pilot was unable to hear the transmissions from LATCC during the descent and before he had slowed the aircraft to 150 kt at FL 110, due to the noisy cockpit environment produced by airflow noise and the captain flailing on the outside of the aircraft.

To	From	Recorded Intelligence
LATCC	BAW 5390	Mayday mayday - - London this is the speedbird five three nine zero mayday mayday mayd-
BAW 5390	LATCC	Speedbird five three nine zero Roger mayday acknowledged out
LATCC	BAW 5390	---- ??? ??? ??? Speedbir- (0733)
BAW 5390	LATCC	Er Speedbird five three nine zero er confirm acknowledge mayday
LATCC	BAW 5390	Mayday mayday
BAW 5390	LATCC	Er Speedbird five three nine zero London Control one three two d- decimal eight mayday acknowledged
LATCC	BAW 5390	Speedbird five ??? ??? zero mayday mayday mayday emergency depressurisation on a radar heading of one nine five descending to flight level one hundred
BAW 5390	LATCC	Speedbird five three nine zero mayday acknowledged understand er descending flight level one zero zero on heading one nine five degrees
LATCC	BAW 5390	(0734) Speedbird five three nine zero is maintaining one one zero -
BAW 5390	LATCC	Speedbird five three nine zero understand maintaining one one zero

<b>To</b>	<b>From</b>	<b>Recorded Intelligence</b>
LATCC	PAA 34	London from thirty four would you like us to try to relay thirtytwo eight
PAA 34	LATCC	Er it's okay Sir I think he may be receiving  ?      What's that
PAA 34	LATCC	Thirty four er thanks all the same Sir
LATCC	PAA 34	-
BAW 5390	LATCC	And Speedbird five three nine zero how do you read now Sir
LATCC	BAW 218	(0735) Er London Speedbird two one eight good morning er we're descending to flight level two seven zero
BAW 218	LATCC	Speedbird two one eight good morning Sir make your heading now one one five degrees and continue descent down to flight level one one zero to be level abeam Kenet
LATCC	BAW 218	- Speedbird two one eight radar heading one one five descend flight level one one zero to be level abeam Kenet
BAW 5390	LATCC	Speedbird five three nine zero London Control how do you read
BAW 5390	LATCC	Speedbird five three nine zero London Control how do you read (0736)
BAW 5390	LATCC	Speedbird five three nine zero er London Control how do you read now Sir
LATCC	DAN 231	London Dan' two three one good morning flight level two nine zero direct to Berry Head
DAN 231	LATCC	Dan' two three one good morning Sir maintain flight level two nine zero
LATCC	DAN 231	Maintaining two nine zero two three one

To	From	Recorded Intelligence
LATCC	BAL 224A	'Morning London Britannia two two four alfa at three one eight climbing three three zero direct Berry Head
BAL 224A	LATCC	Britannia two two four alfa good morning maintain flight level three three zero on reaching
LATCC	BAL 224A	S- two two four alfa wilco (0737)
LATCC	BAL 224A	Britannia two two four alfa's reaching three three zero
BAL 224A	LATCC	Two two four alfa roger
BAW 5390	LATCC	Speedbird five three nine zero London one three two eight (0738)
BAW 5390	LATCC	Er sorry station calling try again
LATCC	EIN 522	Er London the speedbird five three nine zero's having problems ??? ???
LATCC	BAW 5390	??? ??? five three nine zero do you read
BAW 5390	LATCC	Speedbird five three nine zero read you strength five Sir go ahead now
BAW 5390	EIN 522	Five three nine zero go ahead
BAW 5390	EIN 522	Five three nine zero go ahead London reading you
LATCC	BAW 5390	London this is speedbird five three nine zero this is er speedbird five three nine zero
BAW 5390	LATCC	Speedbird five three nine zero London Control one three two decimal eight I hear you strength five Sir go ahead now
LATCC	BAW 5390	Roger Sir we have had an emergency depressurisation and er requesting radar assistance please for the nearest airfield (0739)
BAW 5390	LATCC	Er speedbird five three nine zero roger can you accept landing at Southampton

<b>To</b>	<b>From</b>	<b>Recorded Intelligence</b>
LATCC	BAW 5390	Speedbird er five three nine zero I am familiar with Gatwick would appreciate Gatwick
BAW 5390	LATCC	Er speedbird five three nine zero roger if you make a left turn now Sir direct to Mayfield
LATCC	BAW 5390	- nine zero if you can er direct me into Southampton affirmative
BAW 5390	LATCC	Okay Sir would you prefer Southampton or Gat- er Gatwick
BAW 5390	LATCC	Er Speedbird five three nine zero confirm you wish to route now to Southampton
LATCC	BAW 5390	Speedbird five three nine zero er we have (fuselage) sorry (heads down) - speedbird five three nine zero - I am maintaining one one zero I am at er one fifty knots requesting radar assistance into Southampton
BAW 5390	LATCC	Speedbird five three nine zero roger er standby Sir (0740)
BAW 5390	LATCC	And speedbird five three nine zero if you er commence descent Sir down to flight level seven zero initially
LATCC	BAW 5390	Descend seven zero five three nine zero
LATCC	RYR 506	London the Ryanair five zero six standing by for descent Sir
RYR 506	LATCC	Five zero six roger cleared down to flight level one one zero level er by Kenet
LATCC	RYR 506	- leaving two one zero for one one zero to be level by Kenet five - five zero six
LATCC	BAW 5390	Confirm height cleared to
BAW 5390	LATCC	Er speedbird five three nine zero you're now cleared down to flight level seven zero if you make one left hand orbit in your present position please Sir be handing you off very shortly (0741)

To	From	Recorded Intelligence
LATCC	BAW 5390	Cleared to seven zero speedbird five three nine zero
BAW 5390	LATCC	Speedbird five three nine zero continue now with London Control frequency is one three four decimal four five they will see you into Southampton
LATCC	BAW 5390	- four four five thanks very much
BAW 5390	LATCC	Bye
BAW 218	LATCC	Speedbird two one eight report your heading now to London Control frequency is one three two decimal zero five good day
LATCC	BAW 218	One three two zero five with heading speedbird two one eight good day
EIN 602	LATCC	Shamrock six zero two contact London Control one three three decimal four five good day
LATCC	EIN 602	- Three four five
EIN 522	LATCC	Shamrock five two two contact London one two seven decimal seven good day
LATCC	EIN 522	One two seven seven five two two (0742)
RYR 506	LATCC	Ryanair five zero six make your heading now zero nine five degrees
LATCC	BAW 5390	This is ??? ??? ??? nine zero descending out of eight zero for seven zero - no if you could hold on if you could hold onto him
BAW 5390	LATCC	Er speedbird five three nine zero roger remain on this frequency then Sir and I will give you radar vectors into Southampton
LATCC	RYR 506	- Er London confirm radar heading zero nine zero for Ryanair five zero six

To	From	Recorded Intelligence
RYR 506	LATCC	Five zero six make it zero nine five please
LATCC	RYR 506	Zero nine five for Ryanair five zero six
LATCC	BAW 5390	Descending to seven zero Sir
BAW 5390	LATCC	Five three nine zero roger confirm you wish to remain on this frequency
BAW 5390	LATCC	And speedbird five three nine zero continue descent now down to four thousand feet
LATCC	BAW 5390	London it's speedbird five three nine zero
BAW 5390	LATCC	Speedbird five three nine zero how do you read now sir
LATCC	BAW 5390	Roger reading you er strength five I'm afraid er we have some er debris in the flight deck and er could you confirm the frequency you changed me to (0743)
BAW 5390	LATCC	Okay sir if you remain on this frequency sir and continue descent down to four thousand feet please
LATCC	BAW 5390	Four thousand feet on QFE confirm QNH confirm
BAW 5390	LATCC	Affirmative sir
LATCC	BAW 5390	What is the QNH five three nine zero
BAW 5390	LATCC	Standby sir
BAW 5390	LATCC	And speedbird five three nine zero if you check that now on er frequency one three one decimal zero Southampton approach
LATCC	BAW 5390	One three one decimal zero bye bye
BAW 5390	LATCC	Bye
LATCC	OORDL	London oscar oscar romeo delta lima good morning

To	From	Recorded Intelligence
OORDL	LATCC	Oscar oscar romeo delta lima good morning sir maintain flight level eight zero and you can set course from your present position -
OORDL	LATCC	- Direct for the bravo romeo india
SOTON	BAW 5390	- Five three nine zero do you read
BAW 5390	LATCC	Five three nine zero read you strength five sir
LATCC	OORDL	Oscar delta lima maintaining eight zero and proceeding direct er bravo romeo india
BAW 5390	LATCC	Er speedbird five three nine zero how do you read now sir (0744)
SOTON	BAW 5390	----- ton it's speedbird five three nine Z -
BAW 5390	LATCC	Speedbird five three nine zero read you strength five go ahead with your message
BAW 5390	LATCC	Speedbird five three nine zero
LATCC	BAL 224A	Er London it's britannia two two four alfa er speedbird five three nine zero's now talking to Southampton on er one three one zero
BAL 224A	LATCC	Two two four alfa roger thanks a lot sir
LATCC	BAL 224A	Thank you (0745)
SOTON	BAW 5390	Southampton this is speedbird five three nine zero do you read (0744)
BAW 5390	SOTON	Speedbird five three nine zero good morning identified on hand over London radar six miles to the west of Southampton airfield what is your passing level
SOTON	BAW 5390	Roger sir presently leaving flight level six four could you confirm er your QNH please

To	From	Recorded Intelligence
BAW 5390	SOTON	Roger my QNH one zero one nine millibars the runway in use is runway zero two the wind is three five zero degrees at twelve knots
SOTON	BAW 5390	Roger sir I am not familiar with er er Southampton I request you shepherd me on to the runway please (0744:30)
BAW 5390	SOTON	Roger that is copied roll out then on to a heading of one eight zero
SOTON	BAW 5390	Radar heading of one eight zero speedbird five three nine zero
BAW 5390	SOTON	Five three niner zero what is your passing level
SOTON	BAW 5390	Passing level size zero for four zero sir
BAW 5390	SOTON	Thank you and what is your number of persons on board
SOTON	BAW 5390	We have eighty four passengers sir and er I think that will be all until we're on the ground (0745)
BAW 5390	SOTON	Roger that's copied
BAW 5390	SOTON	And we've been advised that it's pressurization failure is that the only problem
BAW 5390	SOTON	Speedbird five three nine zero turn left heading one one zero
SOTON	BAW 5390	Turning left one one zero speedbird five three nine zero
BAW 5390	SOTON	Five three nine zero we've been advised it's pressurization failure is that the only problem
SOTON	BAW 5390	Er negative sir the er captain is half sucked out of the aeroplane I understand I believe he is dead (0745:30)
BAW 5390	SOTON	Roger that is copied
SOTON	BAW 5390	Er flight attendant's holding on to him but er requesting emergency facilities for the captain I I I think he's dead



<b>To</b>	<b>From</b>	<b>Recorded Intelligence</b>
BAW 5390	SOTON	Roger that is copied continue your descent then at two thousand feet QNH one zero one niner make it a nice gentle turn at the moment you're seven miles southwest of the airfield
SOTON	BAW 5390	Five three niner er five three nine zero that's affirm that's er ro-radar heading one one zero descending to two thousand feet
BAW 5390	SOTON	Affirm what is your passing level (0746)
SOTON	BAW 5390	I'm leaving flight er five thousand five hundred feet on ten nineteen
BAW 5390	SOTON	Roger that's copied give you a little bit more space then turn right on to a heading of one eight zero
SOTON	BAW 5390	Turning right onto one eight zero speedbird five three nine zero could you please confirm the er the length of your runway at Southampton is acceptable for er a One-Eleven (0746:30)
BAW 5390	SOTON	Yes it is acceptable for a One-Eleven and I'll just give you the figures very shortly
SOTON	BAW 5390	Er as long as we have er at least two and a half thousand metres I am happy
BAW 5390	SOTON	Er I', afraid we don't have two and a half thousand metres neither do Bournemouth we have a maximum of eighteen hundred metres
SOTON	BAW 5390	Five three nine zero that is acceptable
BAW 5390	SOTON	Roger that is copied
SOTON	G-BS	Bravo sierra sorry to interrupt we're at Hurst Castle (0747)
G-BS	SOTON	Thank you bravo sierra contact Bournemouth frequency one one nine decimal six two

To	From	Recorded Intelligence
SOTON	G-BS	One one nine six two thank you
BAW 5390	SOTON	Speedbird five three niner zero what is your passing level
SOTON	BAW 5390	Speedbird five three nine zero passing level er three eight fifty
BAW 5390	SOTON	Thankyou very much continue descent altitude one seven zero zero feet QNH one zero one niner if I turn you in now you will have fourteen miles is that sufficient
SOTON	BAW 5390	Give me twenty miles speedbird five three nine zero descend to er confirm level clear to (0747:30)
BAW 5390	SOTON	One seven zero zero feet
SOTON	BAW 5390	Cleared to seventeen hundred feet on QFE
BAW 5390	SOTON	Er QFE one zero one seven now
SOTON	BAW 5390	QFE one zero one seven speedbird five three nine zero
BAW 5390	SOTON	Five three nine zero commence a gentle left turn now then onto a heading of three six zero I'll give you twenty track miles to run for touchdown (0748)
SOTON	BAW 5390	Roger sir do you have an ILS frequency
BAW 5390	SOTON	Er negative I have a VOR but it will be radar vectors onto the visual final
SOTON	BAW 5390	Five three nine zero thank you very much we are three greens er and flaps forty five so I'm set up for an approach but make it please very gentle
BAW 5390	SOTON	Yes I will do indeed you are number one in traffic
SOTON	BAW 5390	Five three nine zero thank you
UKA 455	SOTON	Air Ukay four five five are you with me

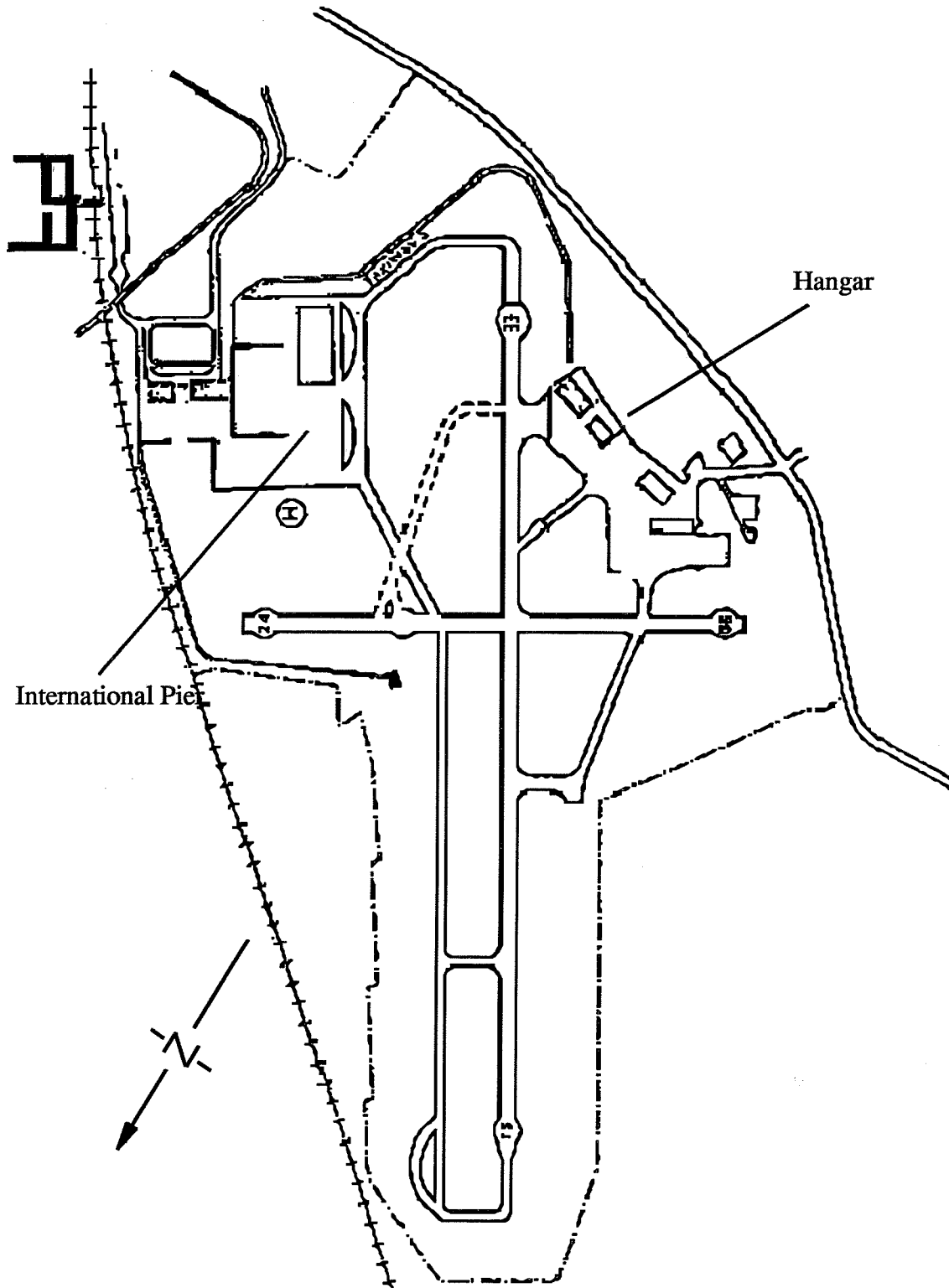
<b>To</b>	<b>From</b>	<b>Recorded Intelligence</b>
SOTON	MAQ 422	Southampton er good morning this is Mac Air four two two er five zero level er holding over hotel romeo november (0748:30)
UKA 455	SOTON	Air Ukay four five five Southampton
SOTON	UKA 455	Yeah we're finally levelling six zero on one two zero
UKA 455	SOTON	Thank you very much turn right now own navigation for Ortac
SOTON	UKA 455	Ortac ukay four five five request level change one two zero
SOTON	MAQ 422	Southampton er good morning mac air four two two five thousand and we're er hotel romeo november (0749)
SOTON	BAW 5390	Speedbird er five three nine zero heading er turning er left onto a heading of due north and levelling er eighteen hundred feet
BAW 5390	SOTON	Thank you make that one seven zero zero feet on the QFE one zero er one seven millibars turn right heading zero two five final approach
SOTON	BAW 5390	Descending on to seventeen hundred feet and turning right onto zero two five er speedbird five three nine zero (0749:30)
UKA 455	SOTON	Ukay four four four five five contact London frequency one three four four five
SOTON	UKA 455	One three four four five cheerio
MAQ 422	SOTON	Mike alfa kilo four four two descend altitude two five zero zero QNH one zero one niner
SOTON	MAQ 422	Leaving zero five zero to twenty five hundred feet one zero one niner mac four two two
MAQ 422	SOTON	Four two two contact Bournemouth frequency one two five decimal six bye bye

<b>To</b>	<b>From</b>	<b>Recorded Intelligence</b>
SOTON	MAQ 422	Two two now to one two five point six so long
BAW 5390	SOTON	Speedbird five three nine zero is nine miles from touchdown you are clear to land the wind indicates zero two zero degrees one four knots descend to height one five zero zero feet on the QFE one zero one seven
SOTON	BAW 5390	Roger sir descending to fifteen hundred feet talk me me down all the way I need all the help I can get
BAW 5390	SOTON	Roger that is copied
SOTON	BAW 5390	We're running on a heading of zero two five five five three nine zero
BAW 5390	SOTON	Roger and er you will be able to stop on the runway to evacuate the aircraft on the runway you are number one you are clear to land (0750:30)
SOTON	BAW 5390	Five three nine zero thank you very much
BAW 5390	SOTON	Your range now is seven miles from touchdown you're on the extended centreline
SOTON	BAW 5390	Five three nine zero thank you very much guidance all the way please
BAW 5390	SOTON	Of course
BAW 5390	SOTON	Your range now is at six and half miles you are clear to land you are on the final approach track
SOTON	BAW 5390	Five three nine zero (0751)
BAW 5390	SOTON	Five three nine zero turn left five degrees you are five miles from touchdown continue your descent at the recommended rate for a three degree glide path (0751:30)
SOTON	BAW 5390	Roger sir if you can er understood

To	From	Recorded Intelligence
BAW 5390	SOTON	You need not acknowledge further instructions unless requested it will be an interrupted talk down but feel free to interrupt if you need to you are clear to land four and half miles on the final approach track heading zero two zero
SOTON	BAW 5390	Emergency facilities er facilities please er and the ambulance
BAW 5390	SOTON	Everything is available for you
SOTON	BAW 5390	Er five three nine zero thank you
BAW 5390	SOTON	Your range is four miles your height should be one two five zero feet and the wind is zero two zero degrees at one zero knots (0752)
SOTON	BAW 5390	Five five five three nine zero thank you
BAW 5390	SOTON	Three and a half miles from touchdown turn right three degrees on the final approach track heading is good
SOTON	BAW 5390	Five three nine zero thank you very much
BAW 5390	SOTON	You're lined up you are clear to land
SOTON	BAW 5390	Five three nine zero
BAW 5390	SOTON	You are three miles from touchdown the height should be nine five er zero feet on a three degree glide path you are lined up you are clear to land (0752:30)
SOTON	BAW 5390	Five three nine zero thank you er I have the runway in sight
BAW 5390	SOTON	Thank you and you are clear to land do you wish me to continue with further information
SOTON	BAW 5390	Negative
BAW 5390	SOTON	Roger remain on this frequency
SOTON	BAW 5390	Five three nine zero

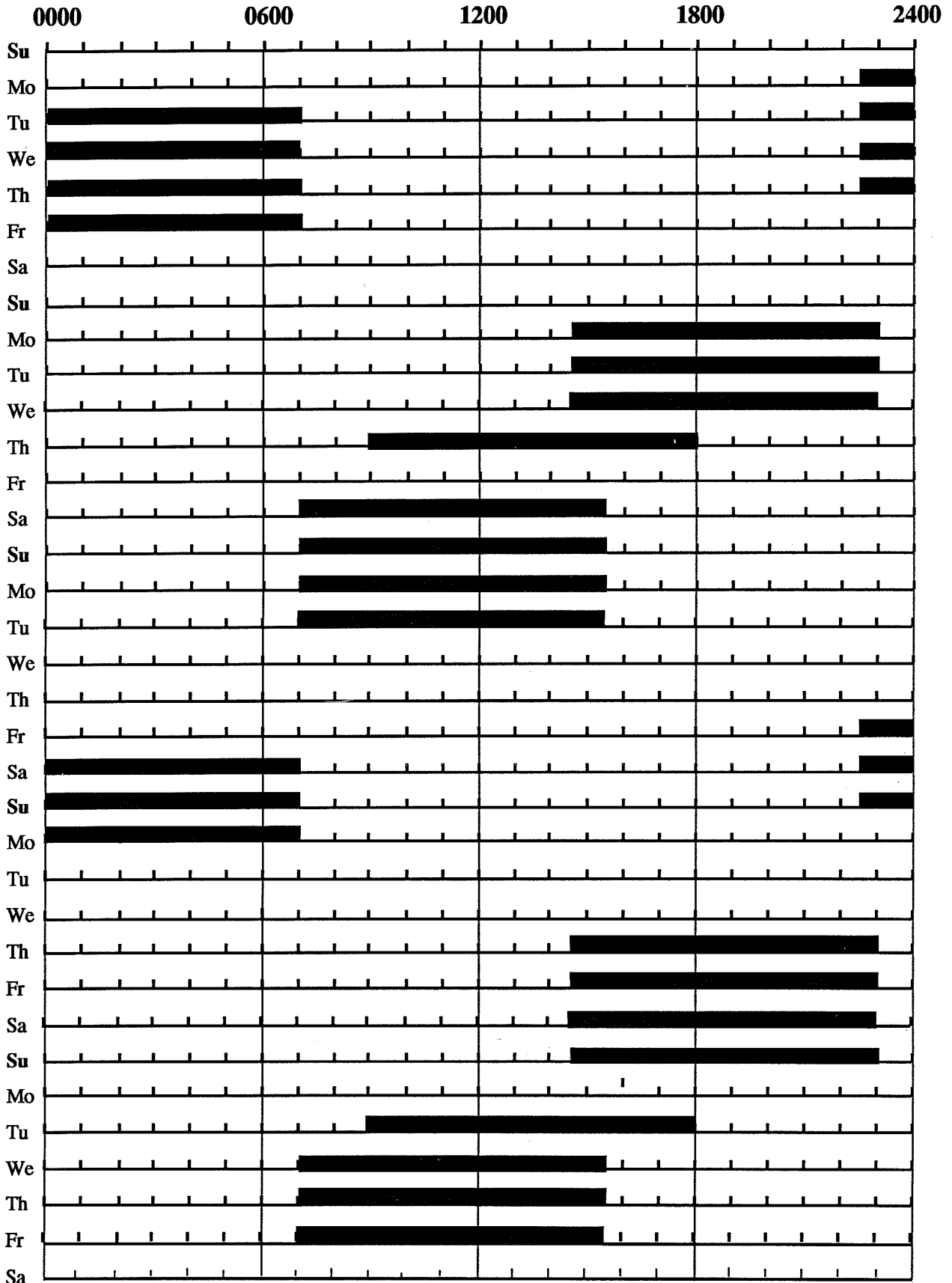
<b>To</b>	<b>From</b>	<b>Recorded Intelligence</b>
BAW 5390	SOTON	Speedbird five three nine zero fantastic approach you may shut down on the runway and leave the frequency
SOTON	BAW 5390	Five three nine zero thank you

APPENDIX B



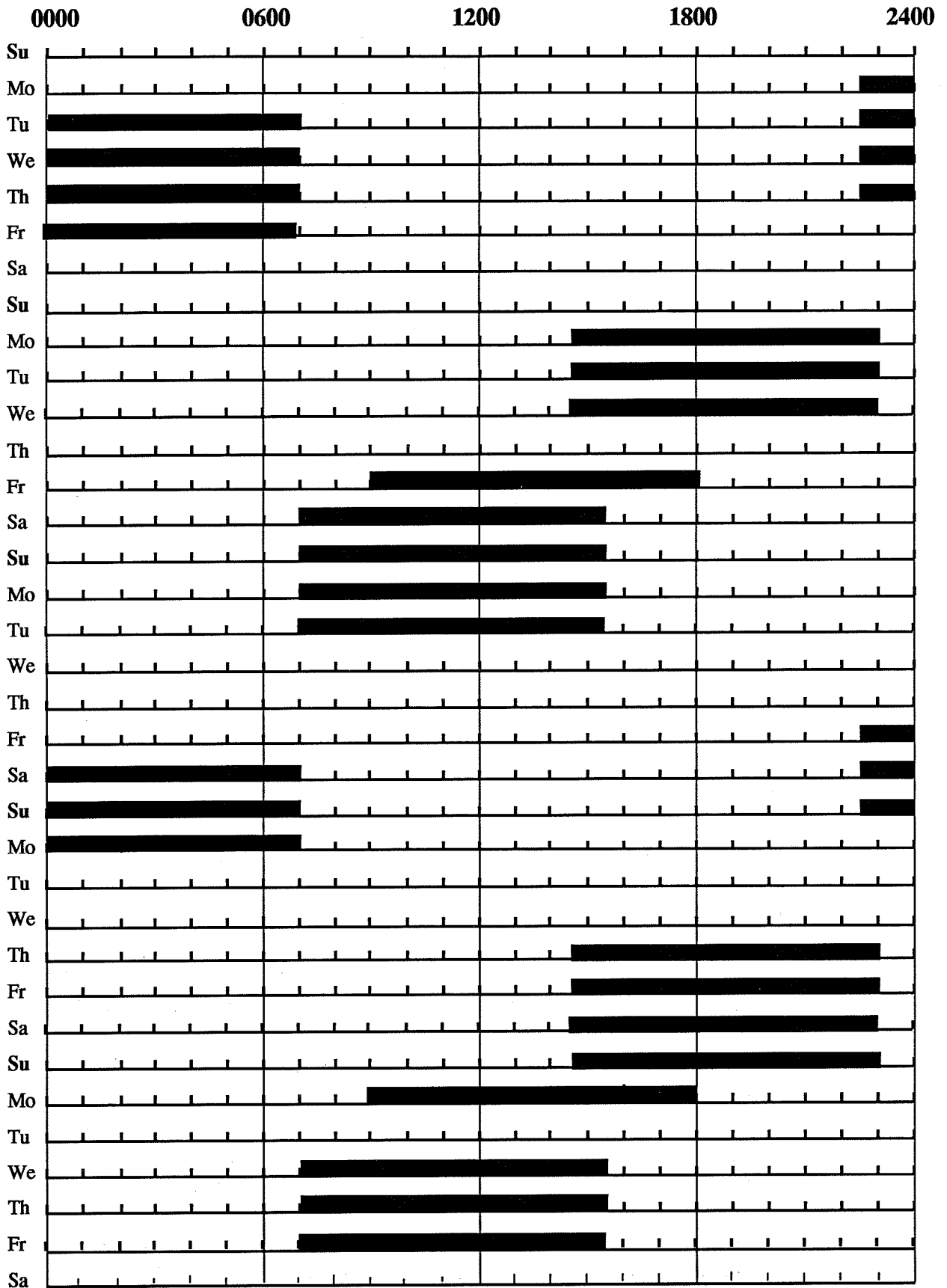
BIRMINGHAM INTERNATIONAL AIRPORT - LAYOUT

APPENDIX C



35 DAY SHIFT PATTERN - Part 1





35 DAY SHIFT PATTERN - Part 2

**QUALITY MONITORING SCHEDULE  
PRODUCT SAMPLE  
(AIRCRAFT ON-LINE AND MINOR CHECK)**

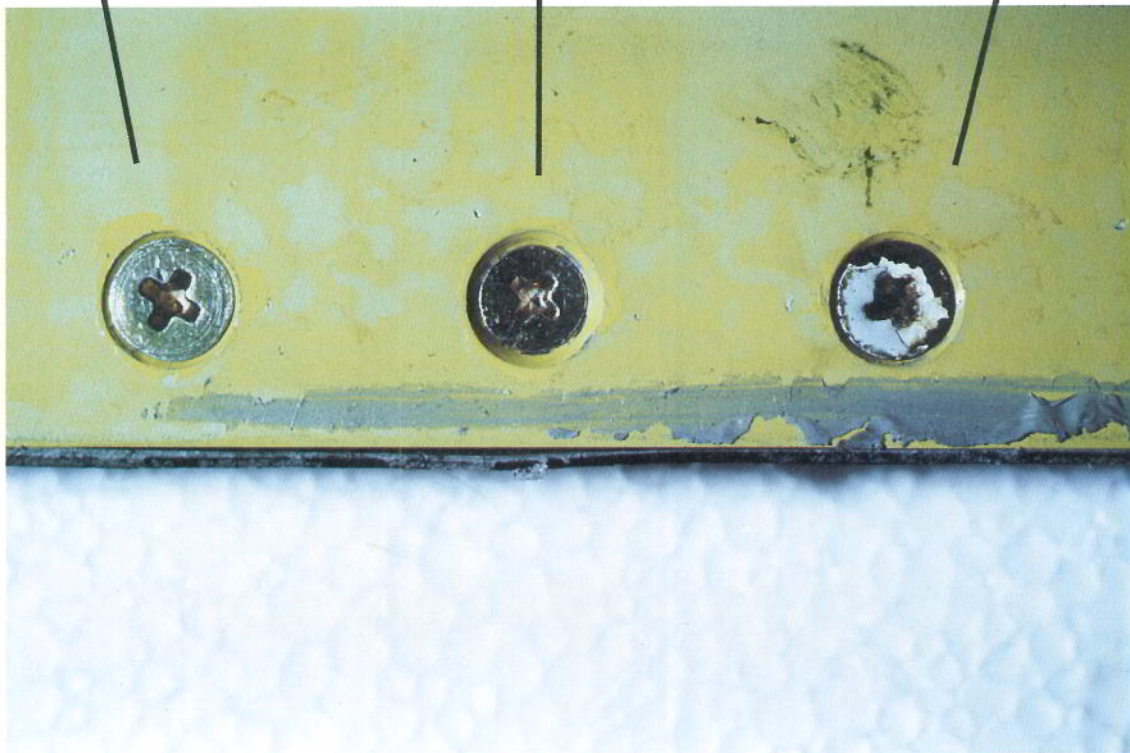
This Form is to be used when applying the Quality Monitor Schedule EDP-MON-01-01 Appendix B item 01.

- 1            Cleanliness: Check areas and assemblies
  
- 2            Condition: check the following for general condition:-
  - 2.1          External airframe and attachments
  - 2.2          Wheel Bays and assemblies
  - 2.3          Service Centres/Equipment Bays
  - 2.4          Engines
  - 2.5          Interior Furnishing
  - 2.6          Flight Deck
  - 2.7          Galleys
  - 2.8          Toilets
  - 2.9          Emergency Equipment
  - 2.10        Decals/notices/documentation
  
- 3            Rectification standards monitor: Select 3 defects actioned during this input and monitor for recurrence and number of further rectifications required to effect a cure over a minimum of 7 days in service. Record the number of recurrences for each defect. Reference defects and highlight by Sect/Log/Defect NO. (The information should be obtained from DISC) and attach to Product Sample.
  
- 4            Functioning: Select specific systems for Test/Part Test to be conducted in accordance with the M.M and in conjunction with Authorised staff.
  
- 5            ATP/Work sheets: Manuals, worksheets and Technical Logs selected for check on amendment state, condition, location, accuracy, legibility, eligibility.
  
- 6            Work carried forward: Current record of ADD and DDA.

New 10 UNF

New 8 UNC

Old 10 UNF



Comparison of bolt heads in countersinks  
(shown approximately 1.9 life-size)

**PSYCHOLOGIST'S COMMENTS**

The human factors issues raised by the fitting of incorrectly sized bolts to the windscreen of this aircraft may be roughly categorised into those directly associated with the individual who carried out the work, and those associated with the system or environment within which he operated. These factors are considered in turn.

**Factors Associated with the Individual**

The errors made by the Shift Maintenance Manager in fitting the windscreen may be listed as follows:

- a. He failed to adopt the ideal procedure of identifying the type of bolt required by reference to the illustrated parts catalogue (IPC), and its location by reference to the stores computer. Instead he simply made a match that relied on his own perception of identity between a used bolt removed from the old windscreen and a new one from the parts carousel drawer.
- b. He failed to heed the storeman who told him words to the effect "They're 8Ds in that windscreen", and continued to make a perceptual match.
- c. In making the perceptual match, he accepted as identical two bolts that are different.
- d. He failed either to notice or to question the significance of the fact that the incorrectly fitted bolts left an abnormally large amount of countersink showing once they had been fitted.
- e. He noticed, when fitting a windscreen the following night that 8D bolts were being used to fit it, believed himself to have used 7D bolts the previous night, but, even so, failed to question the acceptability of his previous night's work.

**Perceptual Problems**

The above factors may be split into those in which he made what could be termed poor judgements or work practices and those that involve perceptual errors. Item c, the failure to identify the difference between the used 7D bolt and the new 8C bolt may reasonably be judged a perceptual error.

The Shift Maintenance Manager claims that he made this perceptual match accurately in the well lit stores area of the hangar, and noted that the used bolt matched with a new size 7D bolt. When he came to make the match in the poorly lit stores of the international pier area, however, he was content that the used bolt matched a new size 8C bolt. He claims that he made the discrimination in terms of both sight and touch. He held both bolts between the forefinger and thumb of one hand while rolling them between the forefinger and thumb of the other.

The subjective similarity of these bolts may not be defined without some form of experiment: it is fair to suggest, however, that they are similar, but not so similar that they cannot be distinguished with reasonable care. The Shift Maintenance Manager does make limited use of reading glasses, which appear to be of a fairly weak prescription, but does not habitually use them at work and was not wearing them on this occasion. Given the poor quality of lighting in the pier area stores, he cannot be regarded as having been in the best visual environment or possessing the best visual equipment for making a visual discrimination that required some degree of acuity.

Item d above may also be regarded as a perceptual error if he failed to perceive that there was more countersink than normal showing around the heads of the 8C bolts. It is possible, however, that he did notice this, but made what might be termed a poor judgement in not acting upon his awareness that the heads looked too far down the countersink. The latter possibility may be regarded as the more likely since, when one of his colleagues spoke with him after the accident, he claims that he remembered that the countersinks had appeared too big - ie, he had noticed extra countersink showing, but interpreted this in terms of an oversize countersink and not in terms of an undersize bolt.

Although such an interpretation may seem extraordinary, it is well documented that individuals who generate an internal model of the world with which they are content often require overwhelming contradictory evidence before they are prepared to reassess their model. This tendency may well be exacerbated when the mental resources required for such reassessment are limited by, for example, sleep deprivation or circadian (time of day) effects.

The effects of time of day on many physiological and psychological variables are heavily researched, the results indicating that the period between 0300 and 0600 is that during which human performance is at its lowest ebb. It is likely that such time of day effects were important both in enabling the Shift Maintenance Manager to fail to make accurate perceptual discriminations, and in terms of enabling him to fail to appreciate the significance of cues with which he was presented. Direct circadian effects are compounded in this instance with some sleep deprivation. As is common among those on a first night shift, he had slept normally the night before his shift, but slept little during the afternoon before going on shift. Thus, at 0300-0500 he would have had a significant requirement for sleep as well as being at his circadian low. These factors may reasonably be regarded as combining to exacerbate the effects described above.

### **Problems of Judgement and Work Practice**

Items a, b, and e above may be regarded as problems of poor judgement or work practice. The Shift Maintenance Manager's failure to use the IPC and stores computer to their best effect, his failure to heed the storeman's identification of the bolts, and his failure to take any retrospective action when he realised the following day that he was using bolts of a different size from those he had used on the same job the previous day, lead to the conclusion that he was not working

with the degree of care that the job demanded. What is less clear, however, is whether he was doing the job in a way that he regarded as being of a standard acceptable to the system within which he was working, or whether he knew that his work practices left a good deal to be desired, but chose to ignore this knowledge in the interests of expediency.

A clue to the solution may be found in the Shift Maintenance Manager's other behaviour and in the opinions of his colleagues. A consistent picture emerges from such considerations. He appears to be regarded as solid and careful by others, and this assessment seems substantiated by his behaviour on the night in question. Although his shift did not start until 1030, he was at work 45 minutes early in order to prepare himself and to get the work of his shift organised. He also continued to work through his meal break. At interview he does not give the impression of one who would take his responsibilities lightly, or behave in a way that he would consciously appreciate as derelict. One is left with the impression that the Shift Maintenance Manager behaved in a way that he felt was appropriate to the circumstances in which he found himself. Overall, his approach to the job could be summarised as conscientious but pragmatic, rather than conscientious and meticulous. A good example of this approach concerns his decision to torque the windscreen bolts to 20 lbf in instead of the specified 15 lbf in. He plainly did not do this as a matter of expediency, but because he felt that this was a better way to do the job. What was missing was an appreciation that such individual work practices are completely out of place in aircraft servicing.

This impression is reinforced by conversation with other shift supervisors. At informal interview, these individuals gave the general impression of being free to tackle jobs in idiosyncratic ways, and when informed of the manner in which the Shift Maintenance Manager behaved on the night in question they did not (except one individual) regard this as unreasonable or demanding of censure. It does not seem unreasonable to suggest that the general climate in the maintenance facility at Birmingham was not one in which the care and safety awareness exhibited by the staff matched the criticality of the task. The nature of the maintenance operation at Birmingham and the setting and checking of operational standards is therefore examined below.

## **The Operating Environment**

### **Inspection**

A procedure included in many industrial operations that have safety implications is that of independent inspection of work. It is possible that independent inspection would have prevented this accident since the poor fit of the bolt heads in the countersinks was potentially observable. There are some more important general points that may be made about the utility of inspection in safety critical systems:

- a. Independent inspection does not have a small effect on the possibility of a maintenance error going undetected, but reduces it dramatically. If an individual operator has, say, a .01

chance of not noticing a fault, then the combined probability of two such individuals failing to notice the fault becomes only .0001.

b. If an individual has made an error in work that he has carried out, then (because he has developed a perceptual "set") he is less likely to detect that error than an individual who comes to the task both afresh and in a "checking" frame of mind.

c. The knowledge that work is to be inspected may change the approach of an operator to his task. It could be argued that the operator would become less careful if he felt that inspection would pick up his errors, and would make him feel less trusted and responsible. For individuals with some pride in their work, however, the knowledge that their work was to be inspected might well make them more careful since they would not wish to be found to have made a mistake.

e. Inspection is likely to have a general effect on the individual operator's perception of the standards and care expected of him by the system. Inspection of work may serve as a regular reminder to operators that the work they carry out has safety importance, and must be carried out meticulously. It is likely that an operator will perceive the absence of inspection as an indication that the managers of the system regard the cost saving involved as more important than the safety benefit, and this may well influence the Shift Maintenance Manager's general approach to his task.

It is thus suggested that inspection represents an important addition to the maintenance work practices evident in this accident, and that it is especially important for work carried out at night, when errors are more likely to be made, and less likely to be detected by their perpetrators.

Lastly, it is interesting to note in this context that had this windscreen been changed in the Royal Air Force, not only would the work have been inspected, but the aircraft would have been pressure tested on the ground before flight.

#### Maintenance of Standards in Working Practices

There appears to be a stark contrast between the procedures adopted to ensure that pilots adhere to standard operating procedures and to ensure that they are familiar with good working practice and those adopted for maintenance personnel. Although the maintenance environment is checked periodically to ensure, for example, the calibration of equipment and currency of technical information, there does not appear to be any checking of the knowledge of, or techniques used by, the engineers. In the absence of such checks, and in the apparent absence of any courses, instruction, or training designed to ensure that aircraft engineers appreciate the importance of standardised procedures, a meticulous approach to the job, and the consequences of error, it should not perhaps be regarded as surprising that experience and familiarity tend to dull the engineer's conscious appreciation of the critical nature of his task.

It seems that the system operated at Birmingham relied entirely on the "professionalism" of individual shift supervisors to ensure that working practices were appropriate. Whereas it is entirely right to expect a professional approach from such individuals, the wisdom of leaving the safety of aircraft entirely to individual judgement without having any systems for maintaining consistency or for checking that high standards are maintained must be questionable.

### Design Safety

It is obviously highly undesirable that this windscreen assembly should have been designed such that it could be fitted with bolts that were very similar to the correct ones, that could be inserted and engage with the anchor nuts, and yet which failed as soon as they were loaded. It is not asking too much for considerations such as this to be made during design, but the awareness that this type of problem is best obviated at the design stage was not widespread when this aircraft was conceived. It could also be argued that this windscreen should have been designed to be fitted as a plug from the inside of the aircraft - an obviously safe practice in a pressurised hull.

Poor design is further evidenced by the fact that this aircraft was already fitted with the wrong bolts (7Ds instead of 8Ds) in the old windscreen. This is probably because the No 1 and No 3 windscreens are fitted with bolts of slightly different lengths, yet only the shorter bolt is actually illustrated in the IPC. It is difficult to believe that it would not have been easily possible for these windscreens to have been designed so that they were both fitted with the same size of bolt.

When a new windscreen is fitted, it is customary for the engineers to fit new bolts only if those removed were damaged or paint clogged. The relative cost of bolts and windscreen might suggest, however, that it would not be unreasonable for new bolts to be fitted whenever a windscreen was changed. If this were so, the windscreen could be supplied as a kit with a set of correct bolts included.

It may also be observed that, once the type of bolt used on this windscreen is removed from its packet, it carries no identifier, compelling it to be identified by its physical characteristics. It is possible that if its head were stamped with such an identifier (*eg* 8D), then the Shift Maintenance Manager may have used this instead of relying on a physical comparison.