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ABSTRACT

The Working Group on All-Weather Operations of the European Civil Aviation Conference (ECAC) has initiated a study concerning the factors influencing the minium required visibility at take-off. In two special checkout sessions on the KLM Boeing 747 flight simulator, the experimental conditions have been defined for an investigation directed at the minimum required visual reference to control the aircraft after a failure of the most critical engine at an inconvenient moment during the take-off run. An investigation has been carried out involving a large number of KLM Boeing 747 crews, in which a total of 159 aborted take-offs have been performed in low visibility. This report presents the results of pilot comments and ratings as well as measured pilot-aircraft performance data for these take-offs. It is concluded that aborted take-offs can be performed safely in night conditions on runways with 15 or 30 m centreline light spacing with an RVR of as low as 150 m, provided the pilot-flying keeps looking outside and the pilot not-flying gives speed calls.

NLR TR 86050 U

FLIGHT SIMULATOR EXPERIMENTS CONCERNING TAKE-OFF VISIBILITY MINIMA

by

M.F.C. van Gool

SUMMARY

The Working Group on All-Weather Operations of the European Civil Aviation Conference (ECAC) has initiated a study concerning the factors influencing the minimum required visibility at take-off. In two special checkout sessions on the KLM Boeing 747 flight simulator, the experimental conditions have been defined for an investigation directed at the minimum required visual reference to control the aircraft after a failure of the most critical engine at an inconvenient moment during the take-off run.

An investigation has been carried out involving a large number of KLM Boeing 747 crews, in which a total of 159 aborted take-offs have been performed in low visibility.

This report presents the results of pilot comments and ratings as well as measured pilot-aircraft performance data for these take-offs.

It is concluded that aborted take-offs can be performed safely in night conditions on runways with 15 or 30 m centreline light spacing with an RVR of as low as 150 m, provided the pilot-flying keeps looking outside and the pilot not-flying gives speed calls.

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(37 pages total)

1 INTRODUCTION

The Working Group on All-Weather Operations (AWOP) of the European Civil Aviation Conference (ECAC) has initiated a study of a number of factors influencing the minimum required visual reference to control the aircraft during the take-off run in night conditions. The factor expected to impose the most stringent restrictions on take-off minima was considered the need to keep the aircraft on the runway in event of a failure of the most critical engine at an inconvenient moment during the take-off run in night conditions. To investigate this in practice, a flight simulator study has been defined by NLR under contract with the Netherlands Department of Civil Aviation, RLD. First, two checkout sessions were carried out on the Boeing 747 flight simulator of KLM, in which two pilots have performed a number of take-offs including engine failures in different experimental circumstances to define the experimental conditions to be considered for such an investigation, (Ref.1). It was aimed to define a combination of variables that forms the most critical situation that nevertheless can be expected to occur with a reasonable probability.

Based on the results of both checkout sessions a test plan was defined that is in accordance with the intentions mentioned above. (Ref. 2). The experiment has been carried out, using the Boeing 747 flight simulator equipped with a 5-window/4-channel visual system of KLM Royal Dutch Airlines.

A large number of Boeing 747 pilots of KLM has performed one or more take-offs in lower than currently acceptable visibility conditions, in which engine failures were programmed to occur. These runs were carried out after the completion of their regular training sessions. Each participating pilot has been asked to give his opinion concerning the acceptability of the procedure under the given conditions.

Preliminary results were presented at an ECAC AWOP meeting in Stockholm in October 1985. One of the conclusions was that it was considered possible that the results were negatively influenced by the silent cockpit philosophy of KLM. In this crew coordination procedure the pilot-flying (PF) performs the take-off and has to scan the instruments for the decision speeds V_1 and V_R while the pilot not-flying (PNF) and the Flight Engineer (FE) have a monitoring role. Each call from either crewmember will cause a take-off abort.

A crew coordination procedure where the PNF provides speed calls and the PF keeps looking outside without instrument scanning is used by a considerable number of ECAC airlines. In view of this fact it was recommended to include also take-offs with this alternate crew coordination procedure in order to study any differences in the results.

The underlying document presents the results of this flight simulator experiment, both in terms of pilot ratings and commentary as in recorded pilot-aircraft performance data.

2 DEFINITION OF EXPERIMENTAL CONDITIONS

2.1 Results of the checkout sessions

The checkout sessions were carried out with the KLM silent crew coordination procedure.

Factors that were considered were the following:

- The spacing of the centreline lights and the edgelights
- The moment of engine failure:
  - (1) Below V_1 so that the aircraft would have to be stopped on the runway or
  - (2) At V_1 but below V_R so that the the take-off would have to be continued with maximum differential thrust
- Low or high take-off weight (TOW)
- The crosswind direction with respect to the failed engine
- The runway friction

In reference 1 the results of the first checkout session on the Boeing 747 simulator with a 2-window/1-channel visual system have been described and recommendations were made to carry out another checkout session with the 5-window/4-channel visual system that would be used in the definite investigation.

It was concluded from both checkout sessions that the most difficult situation would be an aircraft with a low take-off weight, having an engine failure below V_1, forcing the pilot to stop the aircraft on the runway. The runway braking action was varied between "good" and "medium" with negligeable influence on the pilot opinion, so "medium" was selected for all take-offs.

In the checkout sessions a crosswind of 10 knots was used with different directions with respect to the failed engine side. This did not influence the pilot opinion. For the experiment it has been chosen to have crosswind from the left and to introduce engine failures on either side.

The spacing of centreline lights was considered to be very important. It was possible to use available airport models with centreline light spacings of 15 and 30 m and with different edgelight spacings of 30 m and 60 m.

2.2 Aircraft characteristics

The aircraft loading has been selected such that the take-off weight is 240000 kg with a c.g. position at 23 %. Fuel load was 80000 kg (frozen). The following take-off data were used:

V_1 (dry and wet) = 129 kts ($=V_{mc\ ground}$)
V_R = 129 kts
V_2 = 151 kts
N_1 = 108 %
Initial climb attitude = 18 deg.
A flameout of engine 1 or 4 appeared at an airspeed of 115 kts, well below V_1.

2.3 Runways

Three runways have been chosen because they represent different runway lighting configurations. The longitudinal distances between centreline lights and edgelights are the variables of importance in this respect. The runways used and the distances between between the runway lights are presented in figure 1.
The "braking action" of these runways was always selected as "medium".

2.4 Visibility

All take-offs were carried out in night conditions. Four values of visibility have been used, corresponding to four values of the RVR: 90m, 120m, 150m and 200m. With this visibility the number of visible centreline lights and edgelights are presented in figure 2, taking into account the fact that the first 26 m are cut off by the aircraft's nose and the

presumption that the ratio of Slant Visual Range (SVR) and Runway Visual Range (RVR) is equal to 0.9 for the height of the pilot's eye in a Boeing 747.

More information on visibility under low RVR conditions can be found in reference 3. It is shown that appearance of runway lights on maximum intensity (step 5) in daylight is comparable to the appearance of runway lights on reduced intensity (step 3) in night conditions. In the simulation the maximum available intensity in the visual system was used in night conditions. According to pilots this situation is comparable to reduced intensity in real life.

2.5 Wind and turbulence

In all cases the wind was programmed as a steady 10 kts crosswind from the left. No turbulence is assumed.

3 CONDUCT OF THE EXPERIMENT

The piloting task consisted of a take-off under the given conditions. A flameout of an outboard engine was programmed to occur at 115 kts, which is clearly below V_1 (129 kts), so that the take-off had to be aborted.

Participating pilots and simulator instructors were informed on the purpose and conduct of the investigation before the investigations started by means of a written briefing.

To preserve the element of surprise, the pilots did not get more specific information than that they had to perform a take-off in lower than currently accepted visibility conditions. Of course the simulator instructors were informed precisely on the programmed conditions. At the start of the project it was intended to have at least 25 exposures to each combination of runway and RVR. This implies that a total of 12x25 = 300 runs would be made. However in practice this proved to be impossible due to scheduling constraints of KLM and a more limited program was carried out as indicated in figure 3.

Pilots were asked to complete a questionnaire after the session. The questionnaire is presented in appendix A and forms were available in the briefing room. Each pilot completed one form in which questions were asked concerning both the run that he performed as pilot-flying and as pilot not-flying.

The second source of information consisted of the results of the performance monitor that was made of each run. The parameters recorded are presented in appendix B.

4 PILOT RATINGS AND COMMENTS

4.1 Pilot ratings

The ratings given by the pilot-flying are presented as a function of the experimental condition (combination of runway and RVR) in figure 4. In this figure and in many of the following figures the results are presented in the form of stacked bar charts in which the percentage of ratings (clearly acceptable/acceptable/marginally acceptable/ unacceptable) are given in different shadings.

RVR values of 90 m and 120 m on Schiphol 01L score a very large percentage of "unacceptable" ratings.

For an RVR of 150 m the number of visible centreline lights seems to be a dominant factor, judging the difference in percentage of "unacceptable" answers for runway 25 and runway 32R of Cologne.

The alternate crew coordination procedure with PNF speed calls, allowing the PF to keep looking outside without instrument scanning, seems to improve controllability considerably, since no "unacceptable" ratings were given, even with the low number of visible centreline lights on Cologne 25.

Clearly the currently accepted RVR limit of 200 m is considered "acceptable" by the large majority and only "marginally acceptable" by one fifth of the pilots. This is an important observation for the calibration of the experiment. If one considers the current limit of 200 m as appropriate, this means that one has to accept that a significant number of the pilots will call it "marginally acceptable".

To establish any relationship of these ratings with the number of visible centreline lights or edgelights only, for each combination of runway and associated RVR values these numbers are given in the horizontal axis of the figure.

When concentrating on the centreline lights (C.L.) for the cases with the silent crew cockpit coordination procedure, it is impossible to explain the ratings on the basis of the number of lights alone, since Schiphol 01L with RVR 90m has the same number of visible centreline lights as Cologne 25 with RVR 150m (4), whereas pilot ratings are very different.

For the number of visible edgelights even less relation seems to exist with the ratings (a very low number of visible edgelights as for the Cologne runways with RVR 150 m (2) only gets one "unacceptable" rating.

These results seem to suggest that both RVR and runway light configuration are necessary to explain the pilot ratings.

It is concluded that with the silent cockpit crew coordination procedure, an RVR of 90 and 120 m is always unacceptable. An RVR of 150m is considered (marginally) acceptable, provided the centreline light distance is not larger than 15 m.

With the alternate crew coordination procedure (PNF speed calls) an RVR of 150 m can also be considered (marginally) acceptable with 30 m centreline light spacing.

However, before accepting these conclusions it should be shown that no other factors than RVR, runway light distance and crew coordination procedures have influenced the pilot opinion. Therefore a number of experimental factors have been investigated in this respect.

a. Session

The KLM training sessions are performed in five shifts of 3.5 hours, starting at 4.30 h in the morning and ending at midnight. They are designated Alpha, Bravo, Charlie, Delta and Echo respectively. The experimental conditions were randomly assigned to the sessions. The pilot ratings are presented as a function of the shifts in figure 5. No significant influence of early morning or late night session can be seen in the distribution of the pilot ratings so this factor is not important.

b. Pilot-flying

It was investigated whether captains have different opinions from first officers. This proved not to be the case as is shown in figure 6.

c. Failed engine no.

The direction of the wind with respect to the take-off direction was kept constant (always 10 kts crosswind from the left) but either no. 4 or no. 1 engine was failed so this factor really concerns whether wind was blowing from the side of the failed engine (no.1) or from the opposite side (no. 4).

The results shown in figure 7 show that the direction of the wind in relation with the failed engine side did not influence the pilot ratings significantly.

d. Run

Both captain and first officer performed an aborted take-off as pilot flying. In principle it is possible that the second run would be different from the first because of the smaller influence of surprise. However, as shown in figure 8, no significant difference between ratings given in first and second run could be found.

e. Takeoff thrust

In spite of the instruction saying that take-off thrust should not be derated, a number of pilots selected lower values than 108%. Values lower than 100% have been considered as a derated thrust take-off. Judging from the results presented in figure 9, selection of derated or full take-off thrust did not have a significant influence on the pilot ratings.

The distribution of the ratings of the PNF was very similar to that of the PF, so no additional information could be obtained by analysing them separately.

4.2 Pilot comments

Some pilots stated additional comments on the questionaire. The following comments were given (between brackets the number of times that a particular comment was repeated):

- Crew coordination must be changed to include PNF speed calls (18)
- Aircraft performance is better than simulator (7)
- Additional training is needed (5)
- Insufficient outside reference is the cause for bad ratings (3)
- Not using reverse thrust could give better results (2)
- Crosswind limits are an important factor (2)
- In night conditions it is difficult to estimate lateral velocity
- Edgelights were used to get back to the centreline
- Low weight is a negative factor
- Slippery runway would make it worse
- Failed engine number should be called earlier by the Flight Engineer (FE)
- In case of incorrect FE call use idle reverse

The remarks on crew coordination procedures indicate that the pilots were well aware of the disadvantages of having to scan the instruments as pilot-flying.

The remarks on simulator performance emerge from a more general feeling of many pilots that simulators can never be fully representative for the actual aircraft, because of missing visual and motion cues.

The remarks on need for additional training should be taken seriously by the airline training departments.

The other isolated remarks are expected to be connected to specific events that happened in the run.

5 PERFORMANCE MEASURES

Pilot-aircraft performance was recorded through time histories of the parameters given in appendix B. From these time histories a number of measures of performance have been derived as indicated in figure 10.

A standard path over the runway is shown for an aircraft having an engine failure of engine no. 1.

Parameters defined include:

- Lateral position relative to the runway centreline
- Longitudinal position relative to the position at the moment of engine failure
- Time since the engine failure
- Airspeed-related parameters during the manoeuvre
- Heading angles during the manoeuvre

At time = T0 the engine fails, the aircraft is on position X0 on the runway, Y0 metres from the runway centreline, having take-off thrust setting of RPM0, moving with a speed of 115 knots with an aircraft heading of PSI0. At time TTHR the pilot closes the throttles, at that moment the airspeed is VTHR. Due to the asymmetric thrust moment the aircraft turns with a maximum yaw rate of RMAX, reaching a maximum heading angle of PSI1. The maximum airspeed that is reached during the manoeuvre is VMAX. The moment that the thrust actually reverses direction is indicated by TREV.

Normally the pilot will steer the aircraft back to the centreline. The maximum deviation from the centreline that is reached is indicated by Y1. This happens after TY1 seconds at a distance along the runway of X1 and the airspeed at that point is V1.

The case that the pilot does not manage to keep the aircraft within the runway bounds is called "exit 1". This is defined as the point where the aircraft centre of gravity reaches more than 18 metres from the centreline, because the main wheels are then more than 23 metres from the centreline (standard runway width is 45 m).

When the pilot steers the aircraft back to the centreline he reaches a maximum heading angle of PSI2 degrees and has a second maximum lateral deviation of Y2 m, mostly on the other side of the runway, which occurs at time TY2, X2 m along the runway since the failure with an airspeed of V2 kts. The case where the pilot does not manage to keep the aircraft within runway bounds is called "exit 2".

Whether a pilot can keep his aircraft within the runway bounds or not is regarded as the prime measure of pilot-aircraft performance. It is postulated that the aborted take-off can be considered as successful if the pilot keeps the aircraft on the runway, whatever happens during the manoeuvre. The other performance measures are considered to be interesting material for training purposes.

The performance measures have been averaged separately over all successful and unsuccessful take-offs with results as indicated in figure 11. The following observations can be made:

In the successful runs pilots closed the throttles approximately 2 seconds after failure. At that time the average airspeed was 125 kts. In the cases with an exit 1, it appears that throttle closure happened 0,6 seconds later at an airspeed of 127 kts.

An interesting observation is that in the runs with the alternate crew coordination procedure (PNF speed calls), throttle closure also took 0.6 seconds more but in that situation it did never lead to runway exits.

In the successful runs an average maximum yaw rate of 1.8 deg/s occurred, leading to a maximum heading deviation of somewhat less than 4 deg. In the runs with an exit 1 the maximum yaw rate was 3 deg/s and maximum heading deviation was 9 deg, both about twice as large as in the successful runs.

Maximum airspeed reached during the manoeuvre was 128 kts (13 knots above the speed at failure).

It took approximately 5 seconds before thrust actually reversed direction.

For the successful runs the average maximum lateral deviation in the first sway was 9 metres, it happened about 430 m along the runway since failure, 7 seconds after the moment of failure with an average airspeed of 115 kts.

The second heading correction was approximately 6 degrees in the opposite direction for the successful runs and more than twice as large (14 deg) for the cases where an exit 2 occured.

The successful runs had an average second lateral deviation of 6 m, 760 m along the runway since the failure, which happened approximately 14 seconds after failure and the average airspeed was reduced to 78 kts by then.

For the unsuccessful runs the airspeed at runway exit was on the average 119 kts in a first exit and 85 kts in a second exit.

A stylized representation of the aircraft tracks over the runway for the different combinations of experimental conditions (runway lighting , RVR and crew coordination procedure) is presented in figure 12. The longitudinal position of the aircraft at engine failure is taken to be zero. The actual lateral position of the aircraft at engine failure is connected to the first maximum lateral deviation along the runway, this point is connected to the second maximum lateral deviation along the runway and all lines are joined on the middle of the runway centreline, 1200 m along the runway from the failure point. Runway exits are shown by outward moving lines at the maximum lateral deviation points. The top row presents the results for the runs with failed engine no. 1, the lower for failed engine no. 4.

Obviously the runs with an RVR of 90 m have a high percentage of runway exits, both first and second exits.

With an RVR of 120 m also a significant number of runway exits occur. The effect of the wind direction is shown by the fact that with failed engine no.1 only first exits are shown and with failed engine no.4 only second exits occur. Of course this can be explained by the tendency of the aircraft to turn into the wind.

For the purpose of the experiment the runs with an RVR of 150m are the most interesting. Runs on Cologne runway 25 without PNF speed calls show a considerable number of runway exits, whereas with PNF speed calls only one run occurred that was classified as an exit because the centre of gravity reached 18.7 m from the runway centreline. This particular run was completed normally and the pilots called it "marginally acceptable". The results are more similar to those for Cologne 32R with the same RVR, suggesting that the extra information of the additional centreline lights has the same beneficial effect as PNF speed calls allowing the PF to keep looking outside.

For reference, runs with the currently accepted RVR of 200 m are also presented. One runway exit is present for this situation, which was considered "marginally acceptable" by PF and PNF. An interesting phenomenon is that the lateral excursions are only slightly smaller than for the successful take-offs in lower visibility. It is concluded that excursions like these are caused by normal pilot-aircraft behaviour for this kind of failure and it may be expected that aborted takeoffs in good visibility will not be very different.

To investigate whether runway exits are caused by other factors than the combination of runway lighting and RVR, a similar analysis as for the pilot ratings has been performed for the factor "runway exit".

a. Session

The distribution of the runway exits over the five sessions is presented in figure 13. Late night sessions (E) seem to produce somewhat more exits than the early morning sessions (A) but the differences are not statistically significant.

b. Pilot flying

As shown in figure 14, there is a small indication that first officers have caused more runway exits than the captains, but the difference is too small to be significant.

c. Failed engine number

Already discussed with the analysis of figure 12, a failure of the engine on the side from where the wind blows causes relatively more first runway exits, whereas an engine failure on the other side causes more second exits.

d. Run

The distribution of exits over the first and second runs within one session is shown in figure 15.
Here an interesting phenomenon occurs. The total number of runway exits is about the same in the first and in the second run, however, in the

first run relatively more first exits occur and in the second run relatively more second exits. This could suggest that the PNF in the first run, observing a first runway exit from his PF, thus being warned about what was going to happen, overreacted to the engine failure and caused a second exit on the opposite side.

e. Takeoff thrust

Use of full or derated thrust on take-off did not result in a statistically different number of runway exits as is shown in figure 16.

An interesting bar chart is given in figure 17 in which ratings of the PF are presented as distributed over the runs with and without runway exits. As expected the runs ending in a runway exit are considered "unacceptable" by a large percentage of the pilots. However, surprisingly some pilots have rated runs with a runway exit as "marginally acceptable" and in a few cases even as "acceptable". No explanation can be given for this bizar fact. Since the experiment was set up to be anonymous, it was not possible to interview the pilots after the results had been obtained to clear up this matter.

The PNF was asked to estimate the speed at which the failure occurred. An average value of 120 kts was mentioned, which is 5 kts higher than the 115 kts at which the failure actually occurred. Estimates ranged from 95 kts to as high as 130 kts

Another interesting phenomenon is the accuracy with which the pilots estimate the maximum deviation from the centreline during the aborted take-off. The answers given in the questionnaire and the actually measured maximum deviations of the aircraft centre of gravity are compared to each other in figure 18. A majority of the estimates is much larger than the actually measured distances. The fact that the pilots are situated about 28 m in front of the centre of gravity can only partly explain this apparent discrepancy (five degrees of heading change is about 2.5 m lateral displacement at the pilot position).

This suggests that either the simulator outside view does not allow precise estimation of distance, or that pilots are poor estimators of distance.

The accuracy does not seem to be influenced by the runway/RVR combination.

6 CONCLUSIONS AND RECOMMENDATIONS

A flight simulator investigation has been carried out involving a large number of KLM Boeing 747 crews, in which a total of 159 aborted take-offs have been performed in low visibility.

From the pilot ratings and comments it is concluded that the current RVR limit for take-off of 200 m is confirmed as an acceptable and safe limit when the performance of crews during aborted take-offs is considered.

It seems to be (marginally) acceptable to lower the limit to 150 m, provided the centreline light spacing is not larger than 15m.

Lowering the limit to 120 m proved to be unacceptable.
The above was found in a situation where the "silent cockpit" crew coordination procedure of KLM was used.*)
For a number of runs carried out with an alternate crew coordination procedure in which the pilot flying keeps looking outside while the pilot not-flying gives appropriate speed calls, the situation of 150 m RVR was also found (marginally) acceptable with a centreline light spacing of 30 m.

It is recommended to investigate the acceptability of take-offs in 120 m with both runway centreline light spacing of 15 and 30 m with the alternate crew coordination procedure.

*) After completion of the experiments, KLM decided to adopt the alternate crew-coordination procedure as their standard procedure.

7 REFERENCES

1. M.F.C. van Gool — Results of a checkout session on the KLM Boeing 747 simulator concerning take-off visibility minima. NLR Memorandum VS-84-011 L.

2. M.F.C. van Gool — Test plan: ECAC investigations on take-off visibility minima NLR Memorandum VS-84-019 L.

3. C.A. Douglas — Appearance of the visual segment under low Runway Visual Range conditions (IALPA 1985).

Runways used:

Runway	Centreline light spacing	Edgelight spacing
Schiphol 01L	15 m	30 m
Cologne 32R	15 m	60 m
Cologne 25	30 m	60 m

Figure 1: Centreline and edge light spacing for the runways used

Number of visible centreline lights:

Runway	RVR 90 m	RVR 120 m	RVR 150 m	RVR 200 m
Schiphol 01L	4	6	8	11
Cologne 32R	4	6	8	11
Cologne 25	2	3	4	5

Number of visible edge lights:

Runway	RVR 90 m	RVR 120 m	RVR 150 m	RVR 200 m
Schiphol 01L	3	4	5	6
Cologne 32R	1	2	2	3
Cologne 25	1	2	2	3

Figure 2: Number of visible centreline and edge lights for each combination of runway and Runway Visual Range (RVR)

Number of runs flown:

Runway	RVR 90 m	RVR 120 m	RVR 150 m	RVR 200 m
Schiphol 01L	30	31	--	24
Cologne 32R	--	--	24	--
Cologne 25	--	--	24	--
Cologne 25 (PNF CALLS)	--	--	26	--

Figure 3: Number of runs flown for each combination of runway and Runway Visual Range (RVR)

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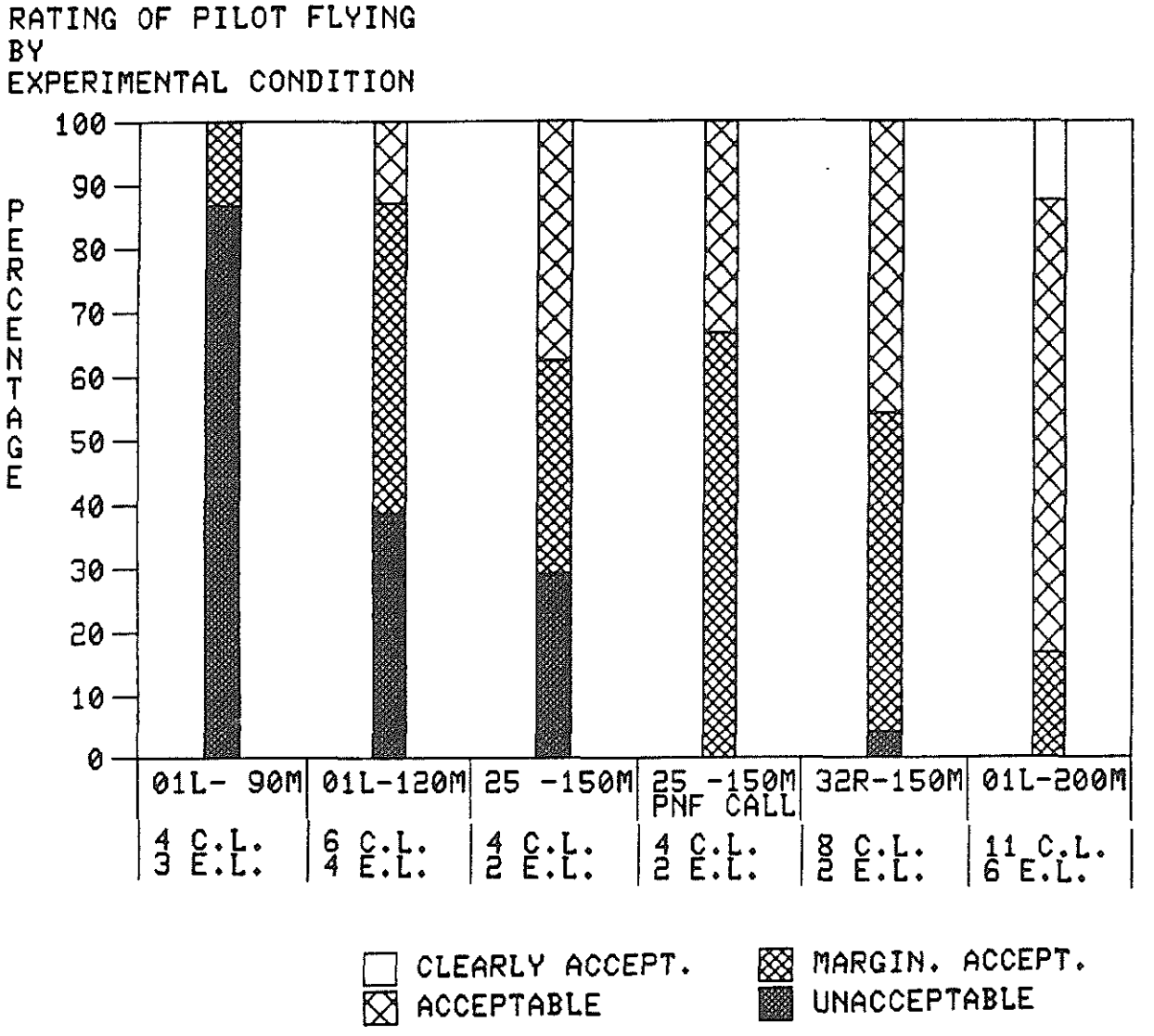


Fig. 4 Percentage of ratings of the PF for the different combinations of runway and Runway Visual Range (RVR)

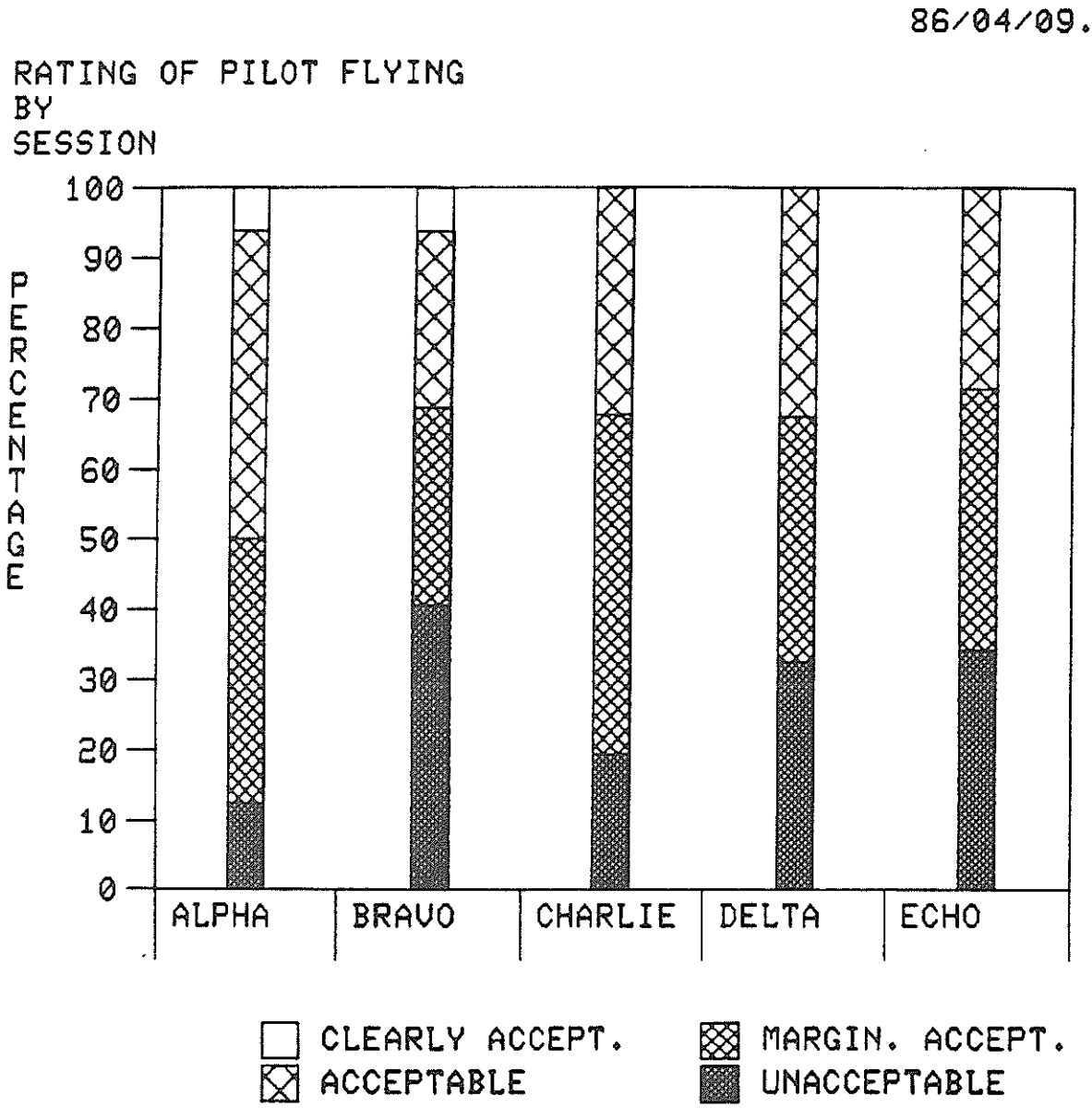


Fig. 5 Percentage of ratings of the PF for the different sessions

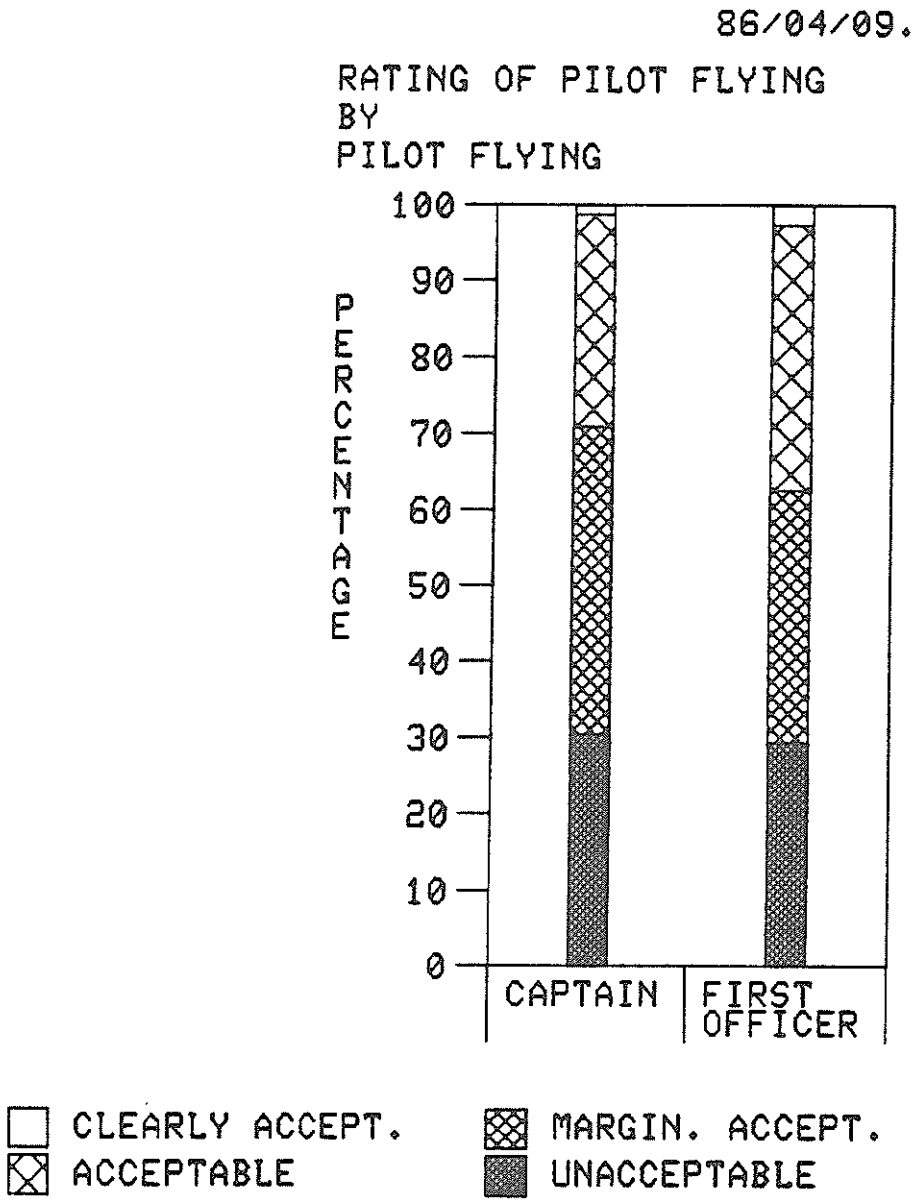


Fig. 6 Percentage of ratings of the PF for the captain and the first officer

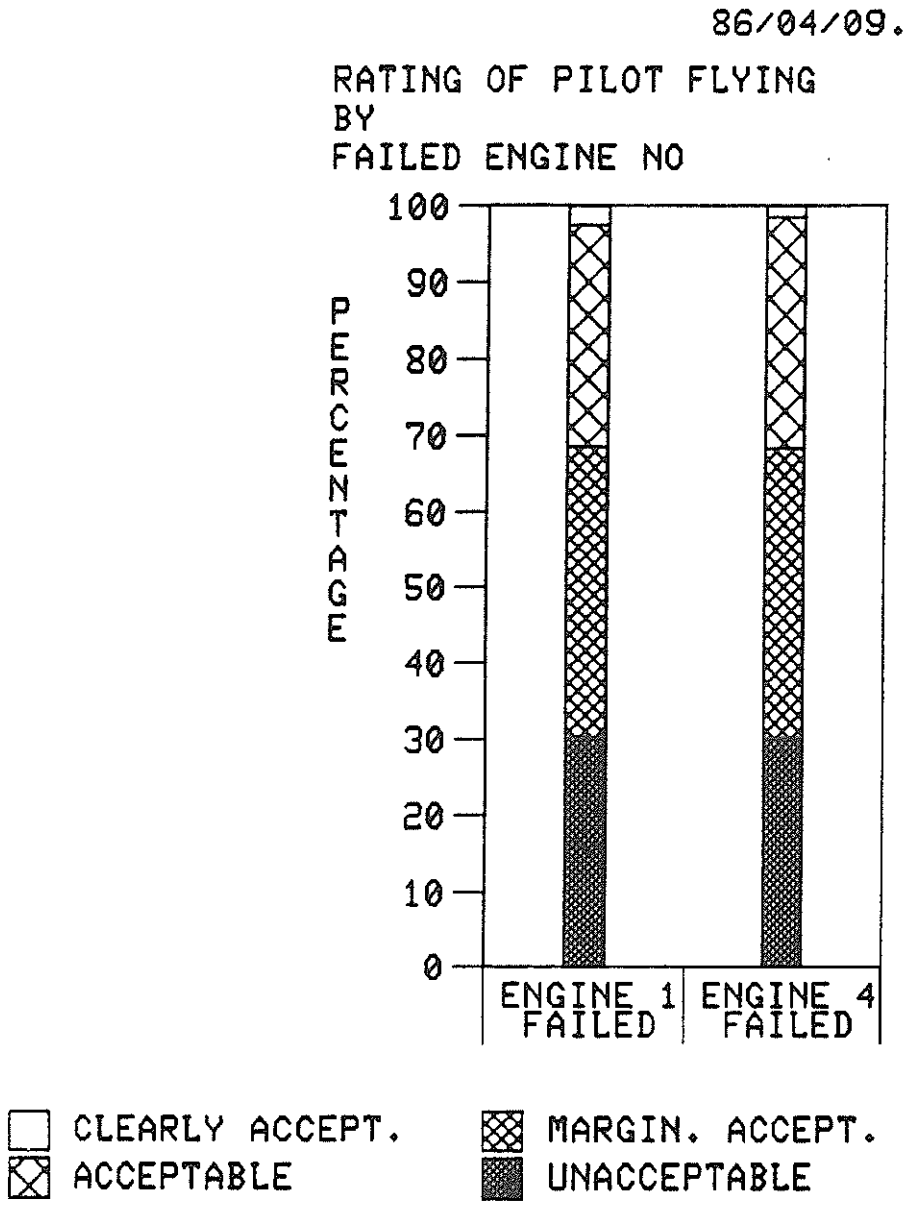


Fig. 7 Percentage of ratings of the PF for the different failed engines

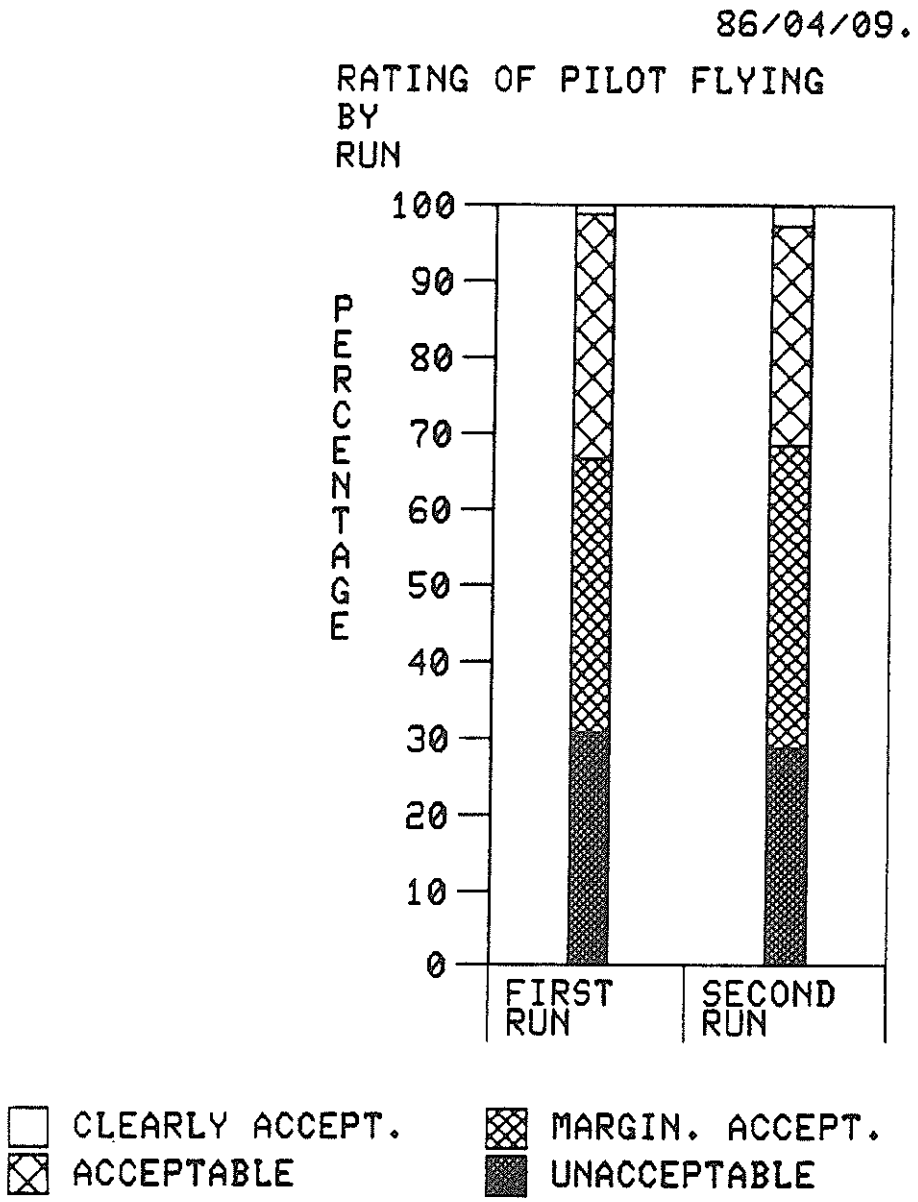


Fig. 8 Percentage of ratings of the PF in the first two runs

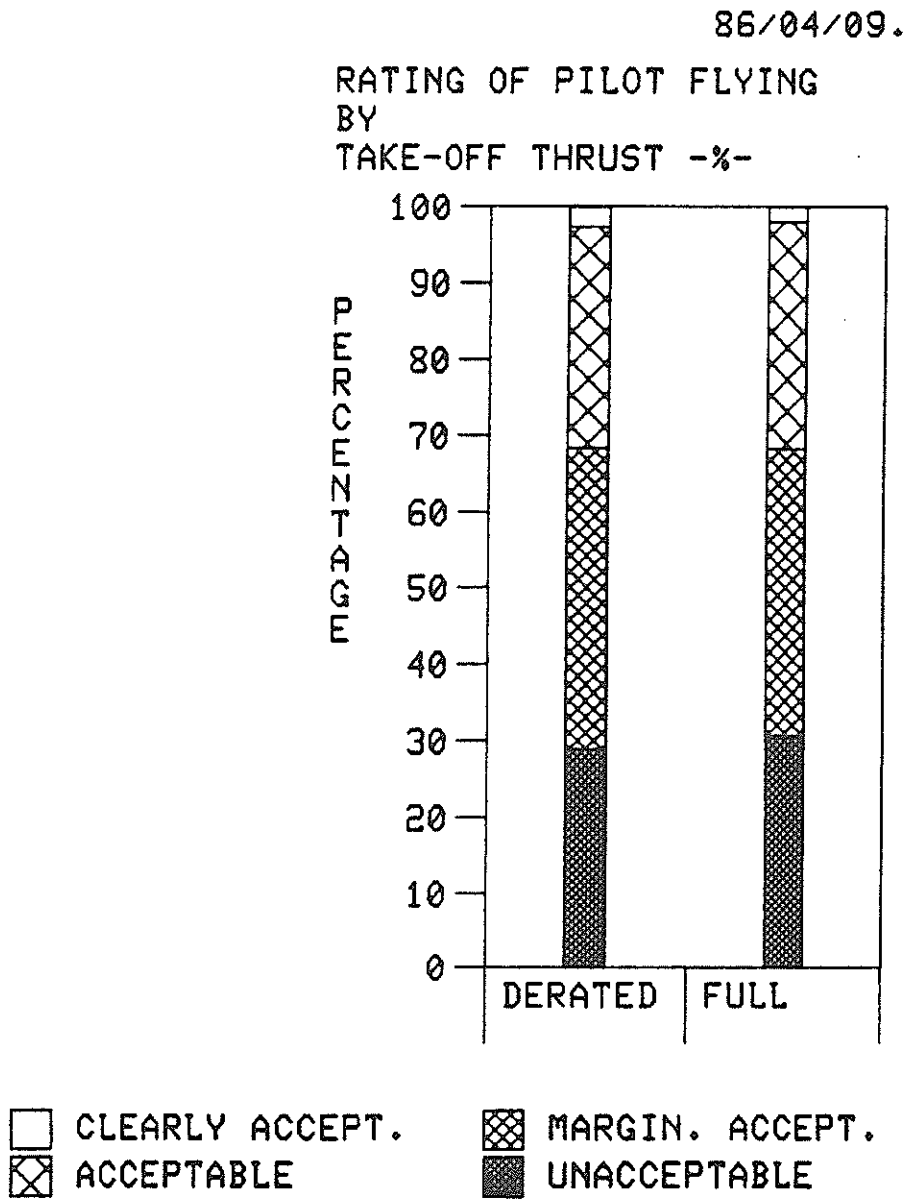


Fig. 9 Percentage of ratings of the PF for the different applications of take-off thrust

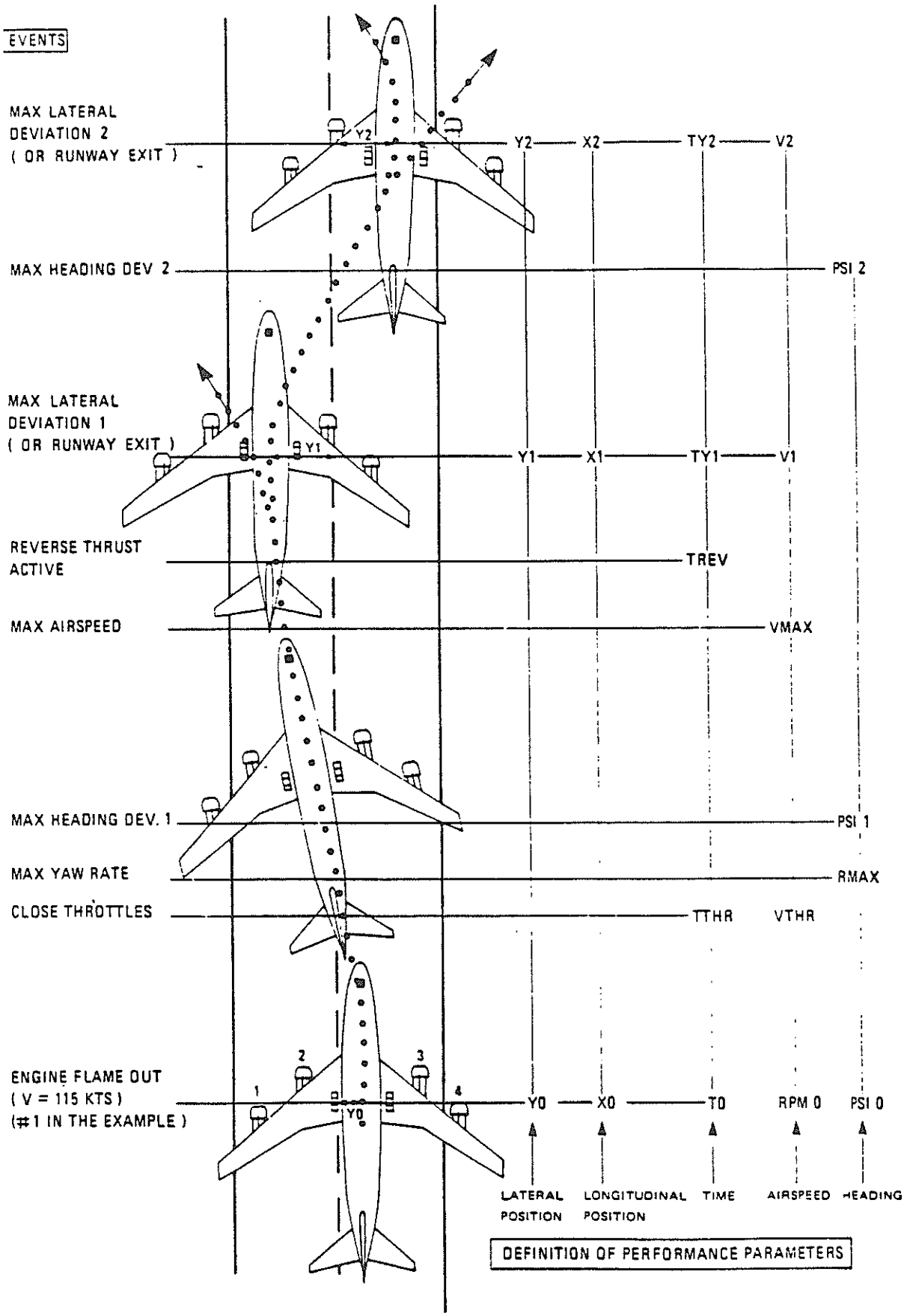


Fig. 10 Definition of performance measures

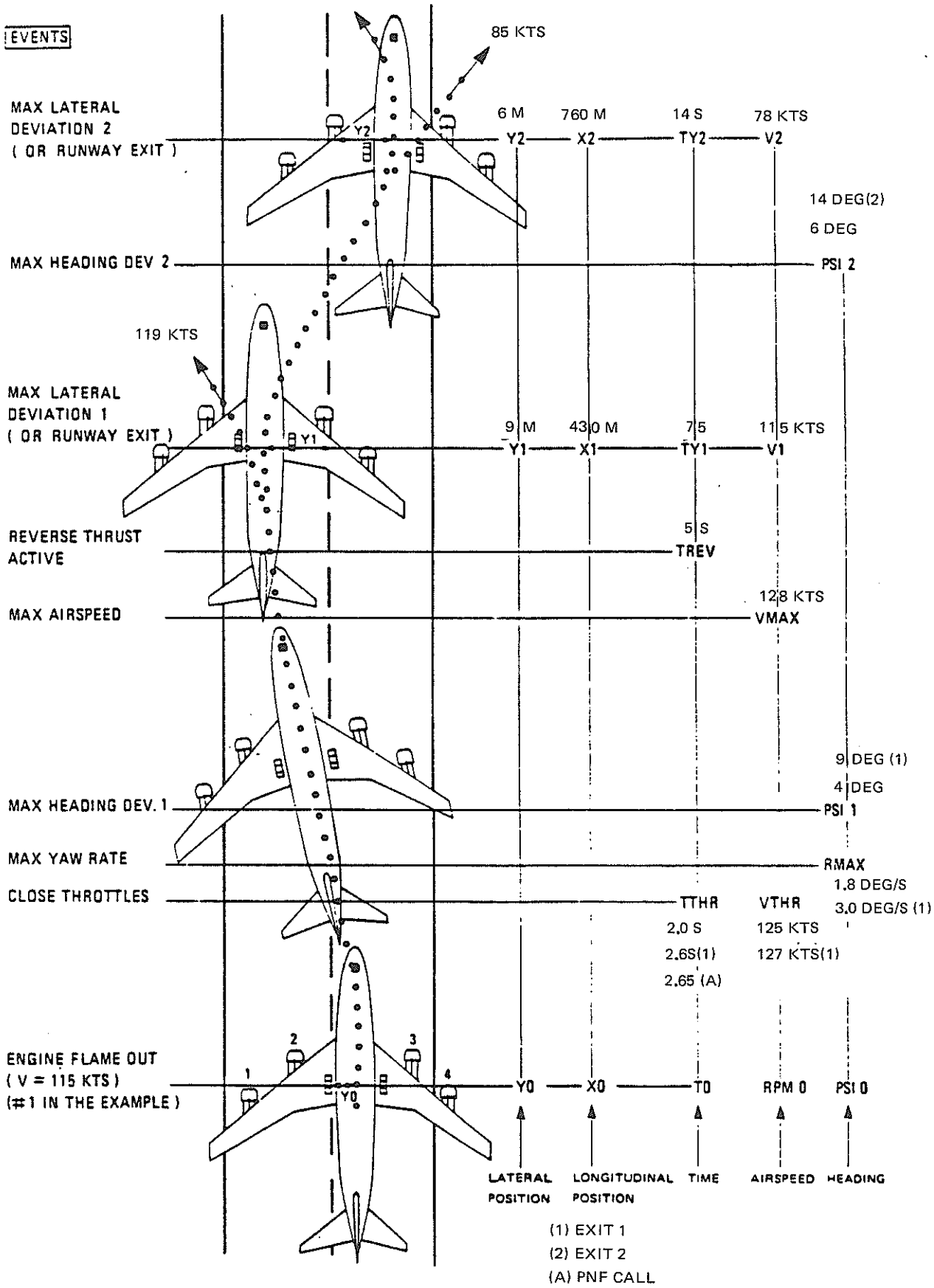


Fig. 11 Mean values of the performance measures

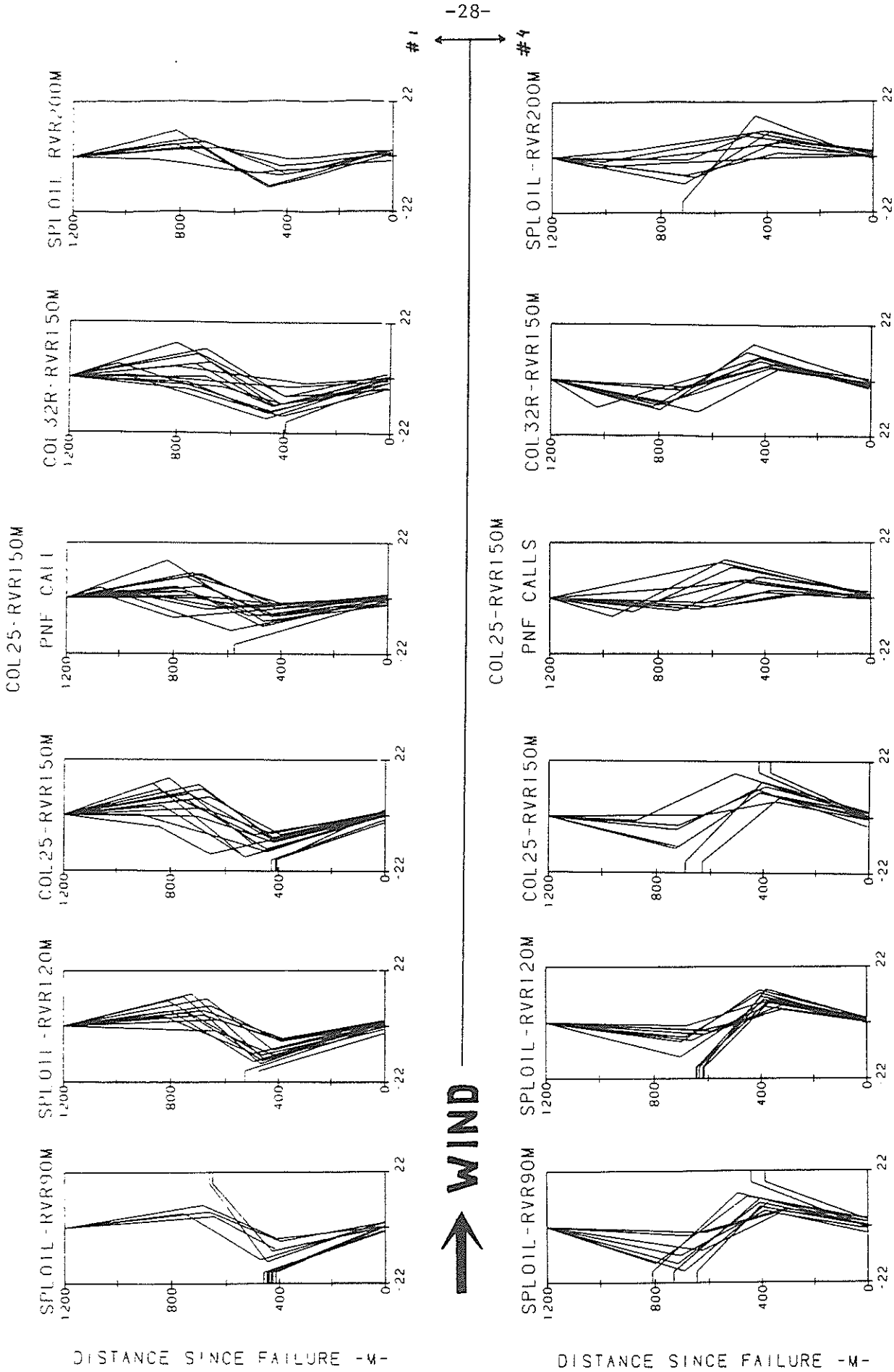


Fig. 12 Stylized representation of aircraft centre of gravity tracks since failure

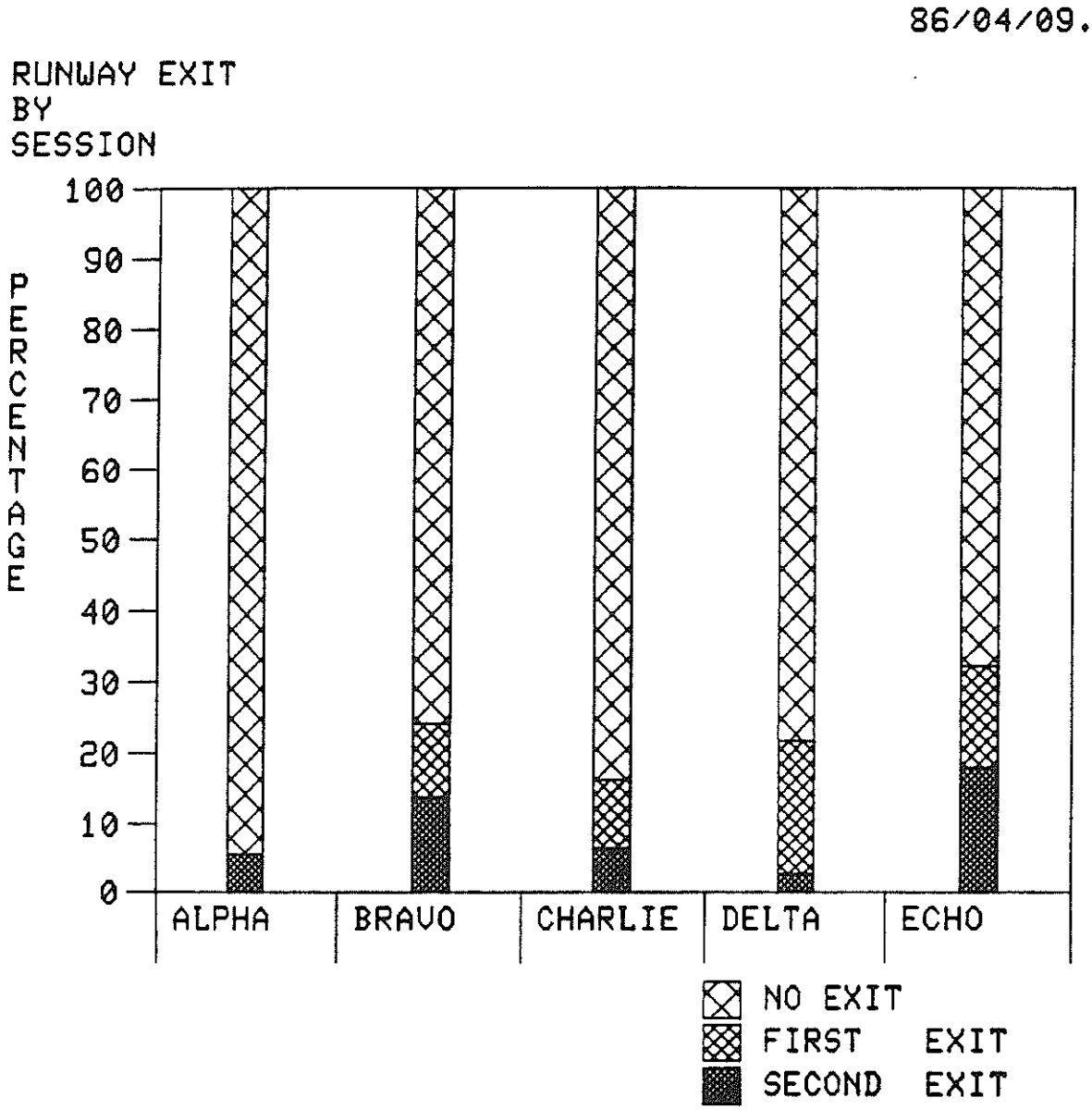


Fig. 13 Percentage of runway exits for the different sessions

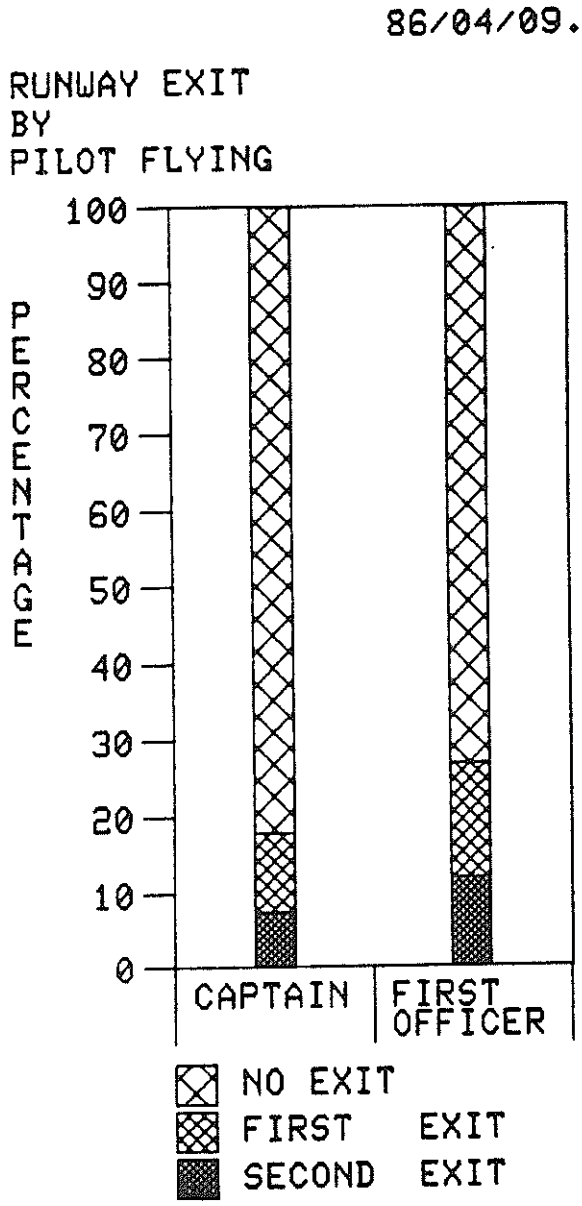


Fig. 14 Percentage of runway exits for the captain and the first officer

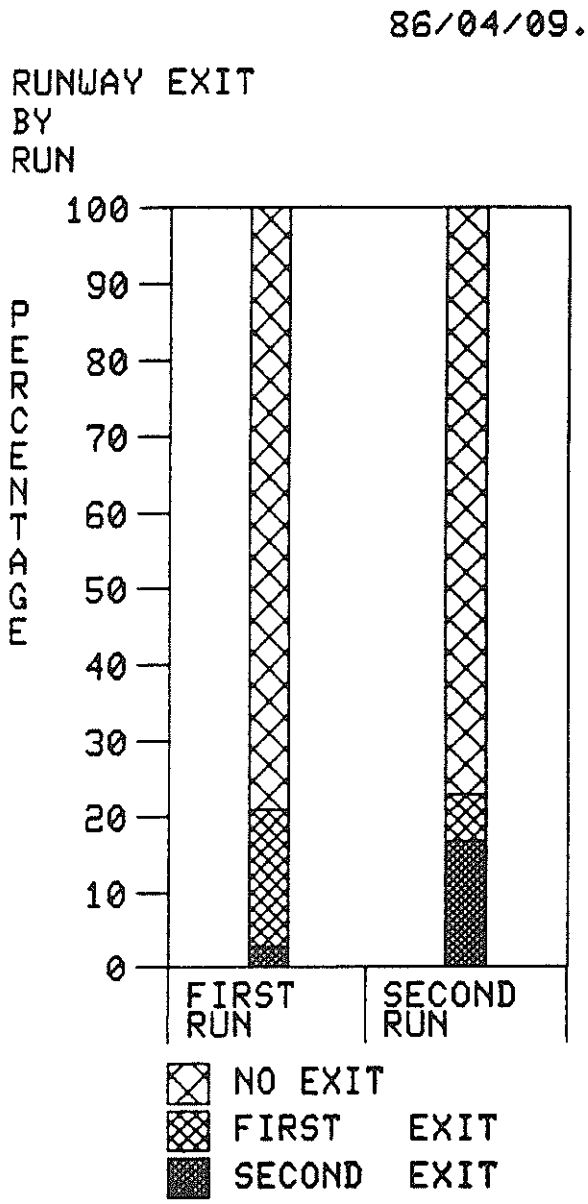


Fig. 15 Percentage of runway exits in the first two runs

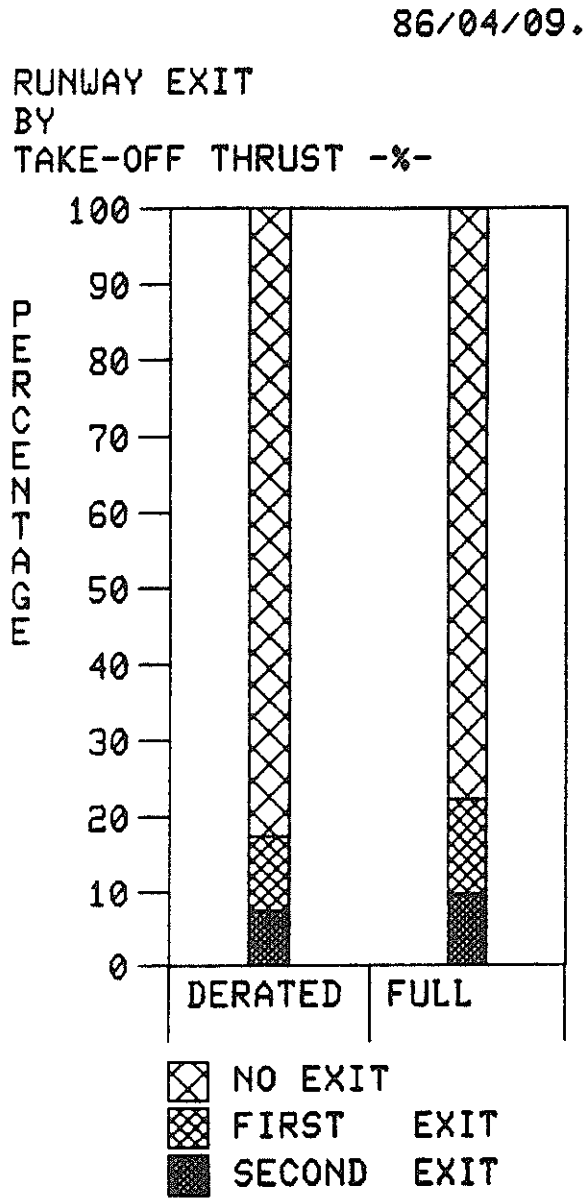


Fig. 16 Percentage of runway exits for the different applications of take-off thrust

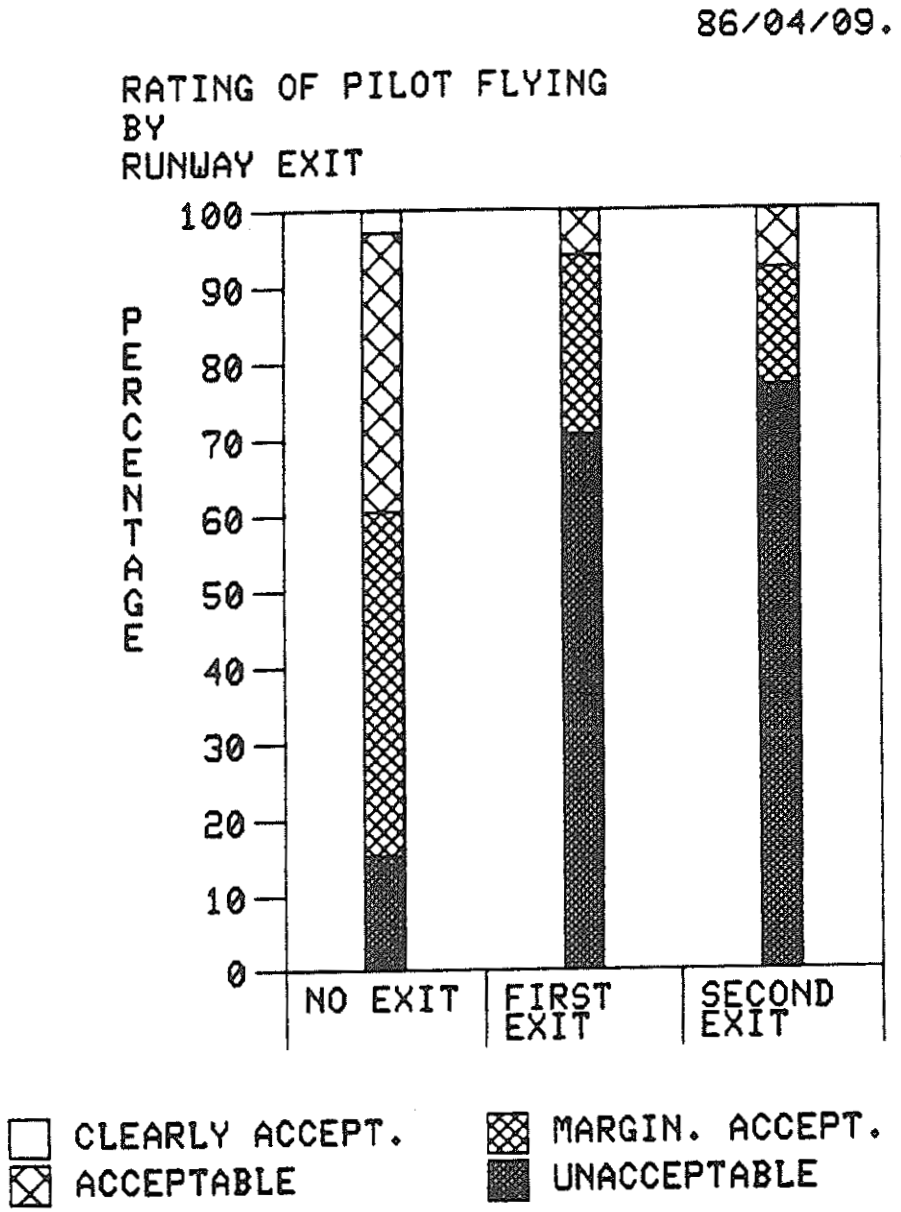


Fig. 17 Percentage of ratings of the PF for the runs with and without exits

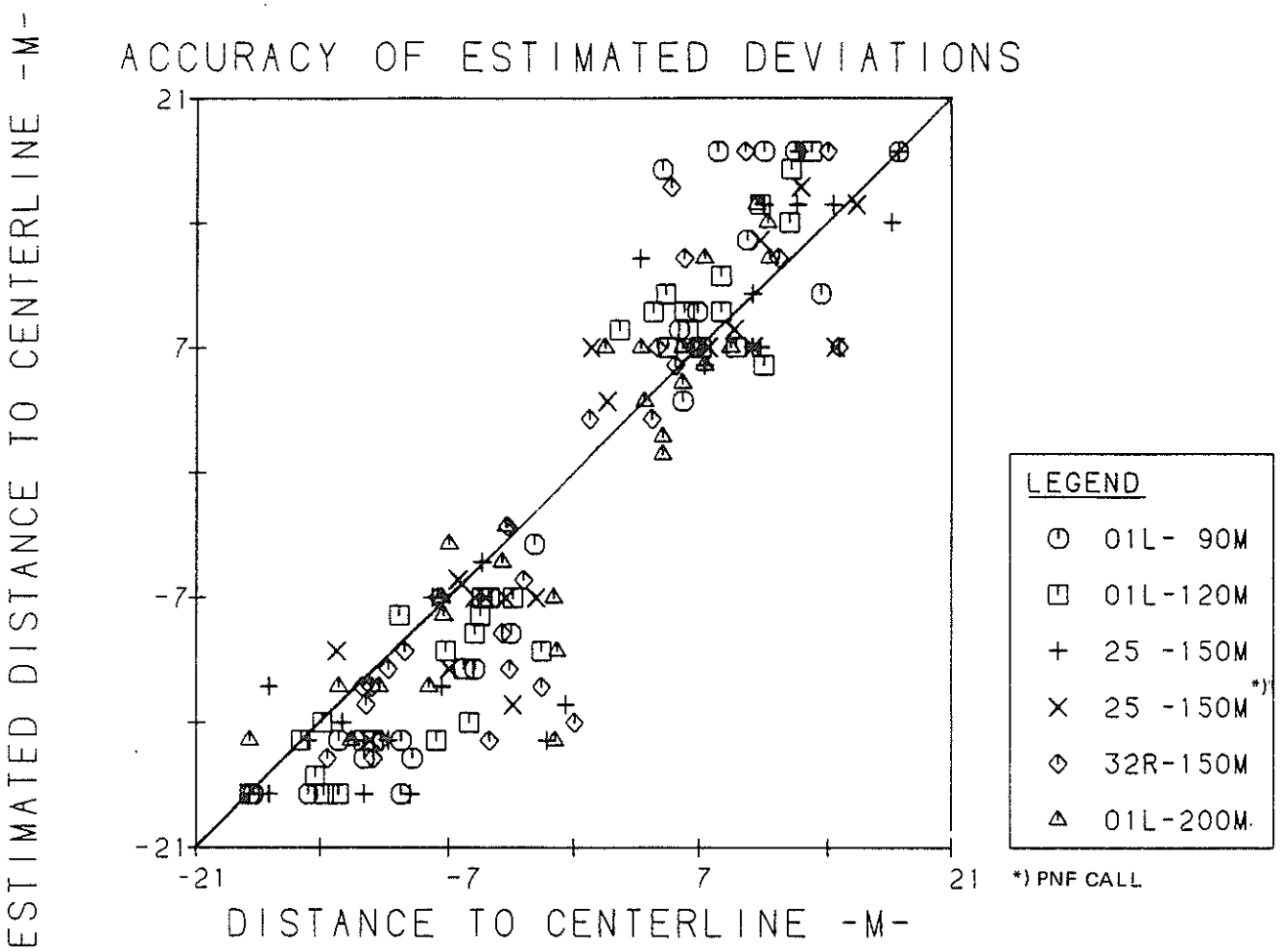


Fig. 18 Comparison of estimated distance to the centreline with the actually measured distance

APPENDIX A: **QUESTIONNAIRE**

ECAC INVESTIGATION ON TAKE-OFF LIMITS

Use one form per pilot
Indicate selected answer by marking the square

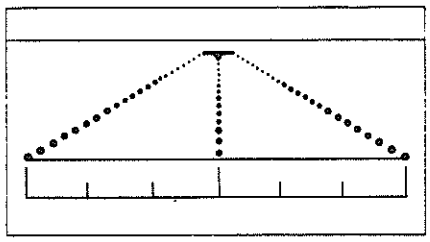
Completed by:

CAPTAIN ☐ **FIRST OFFICER** ☐

Date: ☐ Session: A B C D E

PILOT-FLYING IN RUN NR. 1 2

Indicate the maximum deviation from the centerline you did observe during this run in this figure:



Taking into account the possibility of an engine failure, a take-off under these conditions is in my opinion:

- clearly acceptable ☐
- acceptable ☐
- marginally acceptable ☐
- unacceptable ☐

Remarks. *(continue on reverse side)*

PILOT NOT-FLYING IN RUN NR. 1 2

Estimate airspeed at engine failure. ☐ kts

Taking into account the possibility of an engine failure, a take-off under these conditions is in my opinion:

- clearly acceptable ☐
- acceptable ☐
- marginally acceptable ☐
- unacceptable ☐

Remarks. *(continue on reverse side)*

Remarks RUN

Remarks RUN

APPENDIX B

Performance monitor

Performance monitor:

(Sampling rate 4 samples per second)

Parameters:

1. Yaw rate body axis
2. X-distance of c.g. to runway threshold
3. Y-distance of c.g. to runway centreline
4. indicated airspeed
5. true heading
6. total thrust
7. rudder pedal position
8. wind direction
9. nosewheel position
10. nosewheel normal force
11. aircraft gross weight
12. aircraft centre of gravity
13. throttle position
14. visual model
15. runway friction
16. Runway Visual Range segment 1