

FIFTH SYMPOSIUM ON AVIATION PSYCHOLOGY

**HUMAN FACTORS IN ATC OPERATIONS:
ANTICIPATORY CLEARANCES**

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"Air carrier A instructed to taxi into position and hold runway 9L . . . Air carrier B landing 22R, after slowing was instructed . . . 'hold short of 9L' . . . Air carrier B acknowledged . . . I cleared air carrier A for takeoff on runway 9L. I watched air carrier B and it appeared that air carrier B was not going to hold short of 9L. I then said 'Air carrier B stop! Air carrier B stop!' By then air carrier A had already aborted. B was 20-30 feet onto runway 9L." (ASRS Record 30827)

INTRODUCTION

The NASA Aviation Safety Reporting System (ASRS) periodically convenes the aviation community for roundtable discussions on the ASRS program and its research agenda. At one such meeting, it was suggested that ASRS examine its incident reports for problems involving the use of "anticipatory clearances." Such clearances were not precisely defined, but it was understood that the participant was referring to fast-sequence clearances used by controllers to expedite traffic flows in high volume situations. In the parlance of the trade, these sometimes involve "squeeze play" situations.

Controllers giving such clearances presume that everyone will be alert, act expeditiously, and will maintain adequate separation as the pertinent landing, takeoff, and taxi operations are executed. ASRS data suggest that this is not always the case.

Air traffic volumes continue to mount, but the amount of available runway "concrete" remains basically fixed. The use of anticipatory clearances is expected to grow in response to these traffic pressures. Accordingly, this study of control problems arising from the use of anticipatory clearances addresses the future even more than the past.

Formal Definition

By ASRS's definition¹, anticipatory clearances pertain exclusively to terminal operations. They are given when:

- (1) A controller clears an aircraft, **B**, to use, approach, pass over, or pass nearby a runway
- (2) The controller knows that another aircraft, **A**, is already cleared to use, approach, pass over, or pass nearby the same runway

¹ Anticipatory clearances, as defined by the ASRS, bear a close resemblance to a control technique described as "clearances in anticipation" by the FAA ATC Handbook. However, ASRS's definition includes a somewhat broader range of operations than those addressed by the ATC Handbook. NASA ASRS (Pub. 39)

- (3) The projected paths of **A** and **B** are such that a relatively small variation in the expected pattern or timing of either aircraft's movements could rapidly bring them into conflict
- (4) The controller takes **A** into account when clearing **B** but assumes that all involved parties (including himself) will act in a safe fashion, and that adequate separation between aircraft **A** and **B** will therefore be maintained.

Examples

- A controller clears an aircraft to land on a runway which is occupied by another aircraft awaiting takeoff clearance
- A controller, in succession, clears two aircraft, in trail, to land on the same runway
- A controller issues landing clearances, in succession, to two aircraft on intersecting runways; he gives a hold short restriction to one of them
- A ground controller clears an aircraft to taxi towards but hold short of a runway after a local controller has cleared an arriving aircraft to land on that same runway or a departing aircraft to takeoff from it
- A helicopter is cleared to fly over the departure end of a runway even as another aircraft is cleared for takeoff from that same runway with a traffic advisory.

These are not uncommon operations, nor are they clearly unsafe. However, they are all "anticipatory" in nature and therefore carry some small element of added risk.

OBJECTIVES AND SCOPE

ASRS has embarked on a multi-faceted examination of problems surrounding the use of anticipatory clearances. This study effort is expected to culminate in a published report this summer. Because of space limitations, this paper is restricted to a subset of the issues addressed by the larger study. Here we focus strictly on the human performance aspects of anticipatory clearances. All reported findings are preliminary. Our specific aims in this paper are to:-

- Identify the unexpected events which undermined the safety of the anticipatory clearances described in these reports
- Discuss operational failings on the part of controllers which reduced the safety of anticipatory clearances or which impeded corrective action when conflicts arose
- Describe the types of pilot deviations and other unexpected pilot performances which caused conflicts to arise in the context of anticipatory clearances
- Speak to ways in which both controller and pilot-controller performances could be improved when anticipatory clearances are issued and executed.

APPROACH

Data

Approximately 120 ASRS reports are being used in this study. They were drawn from the 1981 through 1988 time period. The study set represents a very small fraction of total report intake during that period. All of the reports used in this study came from controllers. We needed to know what controllers had planned when they issued anticipatory clearances, and why their plans had failed to materialize. This information could not be supplied by pilot reporters.

ASRS reports are soft data. They are submitted voluntarily and are subject to self-reporting biases. We cannot precisely characterize these biases, but we surmise that our data contain disproportionate numbers of reports in which pilots concluded that anticipatory clearances were imprudent and initiated corrective actions. These might be perceived as "ATC breakdowns" by pilots, who might subsequently raise issues which would cause these events to become "reportable" occurrences.

Aside from this, we have no reason to believe that the reports used in this study are atypical of the larger universe of incidents of which they are a part. ASRS data served us well.

Method

We analyzed our data using the "standardized narrative method." This is an ASRS research protocol which entails the recasting of each relevant report into a set of standardized sentences. The standardized narrative method promotes clear and consistent coding among data analysts. Once coded, our data were analyzed using simple tabulations and contingency analyses.

FINDINGS

The increased use of anticipatory clearances as a traffic volume management tool can be a double-edged sword. The use of anticipatory clearances has proven effective in the management of growing traffic pressures at major terminal locations. However, the application of these procedures has occasionally resulted in losses of prescribed or desired separation in cases when some unexpected event intervened and upset controllers' traffic plans.

Unexpected Events

There are many kinds of unexpected events which can derogate the safety of anticipatory clearances. In the following paragraphs, we describe some of the more common unexpected events seen in this data set.

Failures to hold short. Controllers rely on hold short restrictions to taxiing aircraft or intersecting runway arrivals to prevent conflicts. Violations of hold short restrictions can drastically diminish or eliminate desired separation. If the controller is attending to other traffic and not alert to the developing situation, there is a serious potential for collision.

Unexpected pilot performances on approach. Controllers often issue successive landing clearances to two aircraft in trail for the same runway. On other occasions they issue both a landing and a takeoff clearance for the same runway. When they do this, they depend on pilots to maintain normal approach speeds and to fly normal patterns. Deviations from these norms—e.g., turning to base leg early, landing “hot”, and so on—result in overtake situations.

Unexpected taxi situations. Controllers may issue successive landing and takeoff clearances if they can reasonably anticipate that the lead aircraft will exit the runway before the following aircraft touches down. Pilots sometimes miss assigned (or expected) runway exits, or they are otherwise delayed from clearing the active runway. This results in losses of standard separation.

Human Performances

Some anticipatory clearances are imprudent—they should never have been issued by the controller. In other instances, controllers are the victims of unexpected and unforeseeable events, but even here, vigilance and quick response by controllers can keep a minor conflict from becoming a catastrophe.

When anticipatory clearances are imprudently issued, it is often by developmental controllers during training. Inexperienced controllers try to emulate the timing actions of more experienced controllers. They attempt “squeeze-plays” between arrivals and departures. This results in conflicts. Other breakdowns occur when the instructor controller either allows the trainee to go too far, or when he is not paying attention to the execution of the trainee’s clearances.

One of the most telling findings in our data related to the slowness or lack of response by controllers when an anticipatory clearance had become a problem. Most of the corrective actions reported to ASRS were initiated by pilots rather than by controllers. This can be explained by the focus of attention given to the pending operations by pilots. They are continuously scanning their flight and ground movement paths. In these reports, the controllers issuing the anticipatory clearances were often engaged in other traffic situations and were usually surprised to learn that a conflict had developed from their clearances.

Harried efforts to communicate last-minute corrective instructions to pilots, such as go-arounds, abort takeoffs, etc., can be attributed to the surprise effect of the unexpected conflict. Controller corrective instructions have to be evaluated quickly by the affected pilots to determine their best course of action. Commonly, controllers do not receive an immediate reply from pilots. They may observe the pilot subsequently taking independent, or even contrary, corrective action on their own.

Exhibit 1. CONTROLLER PERFORMANCE DEFICIENCIES

- Not expecting the unexpected
- Forgetting about other cleared traffic
- Forgetting to issue a planned clearance
- Miscalculating landing speed
- Unduly relying on see-and-avoid
- Not issuing traffic to both pilots
- Issuing inappropriate corrective actions
- Taking no action when a problem developed—becoming a passive observer

Exhibit 2. DEFICIENT OR UNEXPECTED PILOT PERFORMANCES

- Failures to Hold Short
- Miscalculations of Available Landing Runway Lengths
- "Hot" Landings
- Tight Base Legs
- Failures to See and Maintain Adequate Separation
- Delayed Initiation of Takeoffs
- Missed Runway Exits
- Alignments with Wrong Runway

Controllers sometimes issued conflicting traffic to one pilot but made no mention of that traffic to the other. Controllers seemed to assume that the "see and avoid" concept would suffice. Pilots were expected to separate themselves upon gaining visual contact. The failure to issue traffic to both affected pilots was a contributing factor in many of these safety events.

Flight crews contributed to the breakdown of many of the anticipatory clearances in this data set. Their failures to adhere to specific ATC instructions calling for an immediate takeoff, cross the active without delay, etc., often confounded controllers' traffic plans.

Exhibits 1 and 2 provide further detail on the kinds of unwanted performances that contributed to these incidents.

SUMMARY OF FINDINGS

Anticipatory clearances are an effective mechanism for expediting traffic. Only a small percentage of ASRS reports describe conflicts arising from the use of these clearances.

Many unexpected events can derogate the safety of anticipatory clearances. Chief among these are pilot actions/inactions such as failures to hold short, unexpected performances on approach, and delayed or unexpected taxi actions. The data confirm that controllers must expect the unexpected and be keenly vigilant when issuing anticipatory clearances.

There is nothing in our ASRS data to indicate that these clearances entail unacceptable risks. However, we have identified steps which can be taken to enhance their safe use.

PRACTICAL STEPS TO ENHANCE SAFETY OF ANTICIPATORY CLEARANCES

Education and Certification

- The concept of anticipatory clearances as a distinct traffic management tool should be made part of the student controller's and student pilot's training instruction.
- Thought should be given to requiring special training and certification of controllers for the management of high volume traffic using anticipatory clearances and related techniques. Emphasis should be placed on expecting

the unexpected, contingency planning, and not using such clearances except when necessary.

Procedures

- Controllers should clear first users of a runway first, e.g., a departure should be cleared for takeoff, where applicable, before clearing an arrival to land on the same runway.
- Controllers should be required to inform landing pilots of the available runway distance when they are asked to hold short of an intersecting runway due to other traffic.
- Controllers should be scrupulous in the issuance of traffic advisories when anticipatory clearances are issued as required by the ATC Handbook.
- Controllers can achieve safety through redundancy when issuing anticipatory clearances by building in both time and space buffers.
- Pilots, when executing an anticipatory clearance, should adhere strictly to the controller's instruction or promptly notify him otherwise.

Restrictions on Use

- Anticipatory clearances should be issued conservatively and only by controllers specifically certified for high volume operations.
- They should be used as a traffic management tool only during high volume periods to expedite traffic—not simply as a matter of operational convenience.