General Disclaimer

One or more of the Following Statements may affect this Document

- This document has been reproduced from the best copy furnished by the organizational source. It is being released in the interest of making available as much information as possible.

- This document may contain data, which exceeds the sheet parameters. It was furnished in this condition by the organizational source and is the best copy available.

- This document may contain tone-on-tone or color graphs, charts and/or pictures, which have been reproduced in black and white.

- This document is paginated as submitted by the original source.

- Portions of this document are not fully legible due to the historical nature of some of the material. However, it is the best reproduction available from the original submission.

NASA CONTRACTOR REPORT 166462

ADDRESSEE ERRORS IN ATC COMMUNICATIONS: THE CALL SIGN PROBLEM

Captain William P. Monan

CONTRACT NAS2-10060
January 1983

NASA

ASRS
Aviation Safety Reporting System

Addressee Errors in ATC Communications:
The Call Sign Problem

Captain William P. Monan
Battelle Columbus Laboratories

NASA

TABLE OF CONTENTS

ABBREVIATIONS AND ACRONYMS

ABC	Code letters used to avoid identifying a location or navigation facility
AIM	Airman's Information Manual
ARTCC	Air route traffic control center
ASRS	(NASA) Aviation Safety Reporting System
ATC	Air traffic control
ATIS	Automated terminal information service
FL	Flight level (standard altitude in hundreds of feet)
F/O	First officer or copilot
FAA	Federal Aviation Administration
FAR	Federal Aviation Regulations
IFR	Instrument flight rules
IMC	Instrument meteorological conditions
NASA	National Aeronautics and Space Administration
U.S.	United States
VHF	Very high frequency (radio communications unit)
XXX	Code letters used to avoid identifying a location or navigation facility
XYZ	Code letters used to avoid identifying a location or navigation facility

PRECEDING PAGE BLANK NOT FILMED

Acknowledgement

The decision to conduct an ASRS research study of the radio call sign problem resulted directly from an infoimation request posed by the staff of the Air Traffic Division Evaluation Branch of the FAA's Northwest Mountain Region Headquarters (ANM-505). That group's astute identification of the problem and of the need to educate the aviation community about it through a forcible demonstration of its existence and nature prompted the ASRS staff, with NASA's firm concurrence, to attempt to confirm that the problem exists and, if appropriate, to provide an educational tool in the form of a Technical Report. We acknowledge this with gratitude. Also, we want to express our appreciation to Mr. Gene Monahan of the ANM-505 staff for his helpful suggestions regarding the conduct of the research and his timely review of the initial draft of this report.

BCL ASRS Staff
January, 1983

ADDRESSEE ERRORS IN ATC COMMUNICATIONS:
THE CALL SIGN PROBLEM

by

Captain William P. Monan[*]

INTRODUCTION

The typical reaction of any airman or controller to the subject of ATC radio communications probably parallels the typical reaction of a housewife to the subject of the kitchen sink. Both items represent important job functions -- must-do activities -- but the tasks involved are too commonplace, mundane, and repetitive to be intellectually challenging or capable of arousing emotional enthusiasm. Yet, the routine of controller-cockpit-controller message exchange is one of the most -- if not the most -- important factors in navigating an aircraft safely through the airspace and the ATC structure. Furthermore, as the Airman's Information Manual states, "The link (between airman and controller) can be broken with surprising speed and with disastrous results"[**].

During the past 4-year period, more than 2,000 reports describing potentially serious aviation incidents involving faulty pilot-ATC communications have been voluntarily submitted to NASA's Aviation Safety Reporting System (ASRS). Within this melange of misunderstood messages, problems with aircraft call signs appeared as major factors. Abbreviated aircraft identifiers, smeared or partially blocked call signs, transposed trip numbers, human factors such as hearing "what you expect to hear" conditioning, misunderstood call ups and a tangled confusion of similar sounding aircraft call signs -- these front-end deficiencies in radio message transmissions contributed significant numbers of hazardous occurrences in airline, corporate, air taxi, military, and General Aviation operations. They were reported causal agents

---

[*]Previously regional director of flight operations for an international airline, Captain Monan serves as an Aviation Safety Research Consultant to Battelle's Columbus Laboratories ASRS Office.

[**]Airman's Information Manual (AIM), Section 190.

for unauthorized climbs/descents, simultaneous takeoffs from intersecting runways, aborts, go-arounds, wrong-way headings, runway incursions, missed crossing restrictions and near collisions, both on the ground and in flight.

In view of this impact upon the aviation system, it is timely to make a critical examination and analysis of the reports depicting the more frequent types of breakdowns in the call up/acknowledgement part of the communication exchange.

APPROACH

From June 1978 through May 1982, 2025 reports involving faulty ATC/pilot communications were submitted to ASRS. Detailed screening of these reports identified 462 occurrences associated with call sign message deficiencies or misperceptions.

Analysis of this data set revealed three characteristic event sequences in the flawed call up/acknowledgement exchanges: controller transmission of a wrong aircraft call sign in the call up message, airman acknowledgement and compliance with a clearance issued to another aircraft, and call up message failures in which an airman neither heard nor acknowledged ATC instructions.

Two of the three event sequences represented double failures in controller/cockpit/controller dialogues. Airmen's acknowledgements for clearances intended for other aircraft and airmen failures to hear/acknowledge ATC instructions developed into reportable incidents only when controllers failed to notice the pilots' errors or omissions. The prevalence of this sequence -- an airman communication error followed by a controller's miss of readback/acknowledgement -- mandated review of communication procedures and responsibilities as currently listed in the Federal Aviation Regulations (FAR), the AIM, and the Air Traffic Control Handbook*.

The causal factors pertinent to all of these call sign communication problems consisted primarily of human performance inadequacies and limita-

---

*FAA Air Traffic Control Handbook, 7110.65.

tions. However, these behavioral patterns never operated independently from system constraints and complexities; heavy congestion on the frequency, controller workload in traffic management, and operational priorities in the cockpit produced very demanding conditions and distracting influences that predisposed the errors in the communication exchanges.

The analysis of the data set resulted in identifying five categories of call sign related errors committed by airmen and controllers singly and in combination. The mechanisms of these errors and the factors predisposing them are covered in the following "Discussion" section of this report.

Two characteristics of the ASRS reporting system are significant to this call sign study. All aircraft designators have been deidentified: letters or numbers (e.g., "ABC", "XYZ", "123") have been substituted for manufacturer or corporate nametags and/or aircraft flight/registration identifiers. Additionally, the ASRS is a voluntary system hence reporter observations must be regarded as unverified statements of individual, subjective viewpoints, and opinions.

DISCUSSION

Faulty Radio Techniques; or, "Mumble, Mumble, --- on Down Wind"

Faulty radio techniques include both mechanical misuse of microphone or speakers and incorrect or inappropriate phraseology. Two types of each technique fault category appeared in the report data set:

- Microphone usage
- Dangling phraseology
- Cockpit speaker usage
- The deliberately over-abbreviated call sign

3

<u>Microphone usage</u>. - The AIM[*] states: "Listen before you transmit....
after pressing the mike button a slight pause may be necessary to make sure
the first word is transmitted". However, the ASRS evidently does not serve
as a normal reporting channel for personal learning experiences in basic
radio communication techniques. Only two airmen submitted comments concern-
ing "mike mumblings" but both indicated that the self-smeared call sign prob-
lem was being encountered "all too often" at small, Unicom fields. "I
believe," theorized a General Aviation reporter, "that the midair collision
problem at uncontrolled airports may be related to the pilot transmissions of
position reports". As one recommendation, he suggested that airmen preface
their in-the-blind transmissions with the name of the airport being used.
"However," he stated, "the word 'at' should be inserted as the first word in
the message to give time for the mike button to be fully depressed".

A commuter pilot's experiences at uncontrolled airports elicited paral-
lel observations:

> "...all too often, the pilot starts talking about the
> same time that he depresses his transmit button. The
> call comes out, 'mumble, mumble, on downwind', or, 'mum-
> ble, mumble, on left base'.

> "All you know from such messages is that someone is some-
> where in the area and you had better start looking hard
> in all directions."

Four other reports suggested faulty mike techniques by ATC controllers.
One of these narratives surmised that an out-of-synch pressing of a foot-
pedal-operated microphone was slurring controller call ups.

> "The controller said, 'Mnffm, unh, right one six zero'.
> I replied, 'What?', whereupon he said, 'Do a right three
> sixty and don't argue'!"

<u>Dangling phraseology</u>. - A less obvious flaw in communication technique,
noted in both pilot and controller reports, was the practice of what might be
called "the delayed dangling phrase". This was the add-on of an explanatory
phrase or sentence to a transmission that sounded, tonally and in contents,

---

[*]AIM, Chapter 191.

4

to have been already terminated. "Negative! I replied", read one such airman's narrative, "then I added, 'We're leaving 10,000 feet for Flight Level two eight zero'". The tacked-on, after-thought, "then, I added" phrases on a congested frequency not only were frequently covered over by another call up but also smothered the initial phrases of the next transmission on the apparently open frequency.

The insidious aural characteristic of the dangling transmission is displayed in the dialogue below:

Air Carrier Pilot:
"XYZ is maintaining zero nine zero degrees ... as assigned".

Approach Controller:
"...turn to one eight zero degrees".

Air Carrier Pilot:
"Roger, XYZ, turning to one eight zero".

Thirty seconds later:

Approach Controller:
"XYZ, where are you going!! You were given zero nine zero. Turn immediately and climb ...".

Only much later, and only by exact recall of the communication sequence, could the puzzled airman "work out how it all happened". He explained, "The other aircraft's call sign must have been cut off by my reply. However, the controller's immediate response made it sound to us that he was instructing us to turn". Since reporters seldom submitted such innocuous and apparently trivial details as pauses or hesitations in their transmissions, how frequently "dangling", run-on phrases blocked other call sign messages could not be determined.

Cockpit speaker usage. - In reverse of faulty microphone techniques, the use of cockpit speakers for reception contributed a number of call sign problems. Three twin engine airmen reported that simultaneous dual reception or simultaneous transmission/reception on separate VHF frequencies had "muted out" ATC call up transmissions. Probably all pilots who have worked with cockpit speakers have encountered the clogged cacophony of sounds when out-

5

puts of two radios are fed through them. The rueful comments of the twin engine airmen reflected such experiences: "If we had used our headsets, we could have heard ATC...", "There was considerable confusion in the cockpit with Center instructions coming in on one speaker and the ATIS on the other." "The clearance to descend in the holding pattern had been for a similar flight number (103 versus 503). Our aircraft has a speaker system: the F/O was talking to the company on one radio and the first numbers in the call sign had been partially muted by the speakers...".

The deliberately over-abbreviated call sign. - Whether bending to urgent time/workload pressures during busy, chaotic conditions or apparently lulled by dull repetition into nonchalant brevity, both controllers and airmen either self-admitted or were reported to have intentionally short cut aircraft call signs during call ups and in acknowledgements.

The practice appeared so prevalent in the system that the majority of reporters framed their individual experiences into sweeping "everyone-does-it" generalizations. "Pilots on this line are lax in dropping their company prefixes...", "A very large percentage of pilots do not use their call signs when changing frequencies: they say 'Bye' or 'Roger'...", "We find several FAA facilities to be very lax in using only airline trip numbers without the company prefix names...", "Dropping the prefix of aircraft types is common during busy, chaotic conditions...", "The simple truth is that only five percent of ARTCC controllers ever use the aircraft type when calling General Aviation aircraft...."

However general the comments, all reports focused upon one single concern: the unauthorized over abbreviations permitted two entirely different aircraft identifications to assume a similarity of sound or of letters or of numbers that could easily be "read" as a transmission to the wrong aircraft.

At best, the results could be confusion, additional workload and concern:

> "Both Bizjets were using only the last 2 digits of their
> call signs when acknowledging various altitude assign-
> ments. As a result, '12SK' and '13AK' caused great con-

6

fusion and required many additional instructions to keep them apart."

* * * *

"I was WRSX5 in the pattern for 31R. A SUS65, with a different manufacturer prefix, was an itinerant arrival, also to 31R.

"Since the controller did not use the manufacturers' pre-fixes, we had 'SX5' and 'S65' both on the frequency. There was confusion -- 'Was that for us?' type of thing.

"It seems that the new controllers are not being trained to recognize the similar call sign problem."

At worst, the prefix dropping practice could precipitate near disasters:

"The problem arose because I did not state the aircraft type when I issued a descent clearance to 'One Two Char-ley'. 'Two One Charley was also on the frequency and also accepted the clearance. However, I did not notice this until I observed his altitude readout at 14,500 feet. (Minimum enroute altitude in his sector was 16,000.)

"I verified his altitude and then issued him an immediate climb. I asked him for his flight conditions and he said he was in IFR.

"There is no doubt in my mind that within another minute or two, Two One Charley would have crashed in the moun-tains."

In an unusual reverse application, an ATC facility apparently "skipped" its identification in a continuing dialogue with an air carrier flight crew. The confused First Officer communicator, who "figured it out later", stated that his quotes of ATC transmissions were verbatim:

"I, the First Officer, called, 'XYZ Center, Air Carrier ABC is with you, descending to FL240'. The controller's reply was, 'ABC, continue descent to one two thousand, altimeter setting 29.94'.

"Since we had just copied the ATIS with an altimeter set-ting of 29.84, I questioned the altimeter. Center came back with, 'No, ABC, altimeter is 29.94'.

"There was considerable discussion in the cockpit about the altimeter differences. Finally, the Captain told the S/O to check with the Company. This was given as 29.81.

"Despite repeated calls, we could not contact the Center again. We switched over to Approach Control, advising them that we were descending to one two thousand.

"The approach controller said, 'There must be a mistake somewhere'. We had not been issued any clearance to leave FL240.

"This is what I believe happened. The controller gave us the wrong frequency -- or else I copied it wrong -- and I contacted GGG Center instead of XYZ Center. Enroute, we had heard another air carrier behind us, going into GGG.

"I believe GGG Center issued us a descent clearance for the other aircraft and failure to use his ID in answering our call led to the incident."

Call Sign Errors, Related to Frequency Congestion; or, "Was That For Us?"

"Pilots...must be certain that aircraft identification is complete and clearly identified before taking any action on an ATC clearance." (AIM, 193b.)

"Precede all readbacks and acknowledgements with the aircraft identification.... The requirement becomes more important as frequency congestion increases..."

(AIM, 265(b)(1).)

Errors related to frequency congestion fall into 3 categories:

- Dilemmas of uncertainty and expectation
- Clearance amendment problems
- Nonstop ATC transmissions

Dilemmas of uncertainty and expectation. - "We heard a call, clearing someone...", "The call sign was garbled...", "The flight call sign was obscured...", "The company prefix was garbled...", "The front end of the transmission was smeared...": frequency congestion, specifically the overlap of aircraft call signs, abruptly injected a painful dilemma into cockpit decision making. The horns were sharpened considerably if "expedite" or "immediate" had been included in the message contents.

8

The pilot uncertainty -- whether to act or not to act -- surfaced in some narratives:

> "I asked the Captain if 'that was for us?' and he said 'he thought so...'"

> * * * *

> "My Captain understood the message to be for us. I was not sure..."

In the majority of incidents, the airmen elected to assume that the smeared call sign message had been intended for their aircraft. This predisposition was puzzling until analysis of the individual narratives indicated a tie-in with the level of cockpit expectancy for a forthcoming clearance. Being momentarily held at an intermediate altitude, awaiting an ATC response to a previous request "for higher", in "position and hold" while standing by for takeoff clearance, approaching normal top-of-descent, distance out points -- these airspace/airport situations supported pilot supposition that "it must have been for us".

The other horn in the act or not to act dilemma was equally pointed. "Waiting to see" if the smeared transmission would be repeated did not avoid subsequent altitude deviations and/or midair traffic conflicts.

> "Initially, we had been cleared to climb to FL310. Once we heard a 'maintain FL250' but the call sign was garbled and so we did not acknowledge it. As we passed through FL265, Center called and asked if we had received our amended clearance to maintain FL250...".

The cockpit decisions not to comply with instructions following a smeared call sign transmission also appeared to conform with the airmen's expectancy levels. Many of the ignored call up messages were associated with the issuance of a prior clearance followed by an amended ATC assigned altitude. Having just been issued a clearance to a higher or lower altitude, immediate change in instructions would not normally be anticipated. Thus, any garbled call sign transmissions would be disregarded by the airmen as "probably not for us".

9

"If doubt exists concerning proper identity", states the AIM, "pilots should use the phrase 'verify clearance'...." Such a query would resolve the "Was that for us?" uncertainty. However, the same voice clutter on the frequency that initiated the call sign ambiguity also frequently prevented timely confirmation of the call up.

"We could not get through to confirm the call..."

* * * *

"I wanted to reconfirm the clearance but could not get through."

* * * *

"We could not get through...so we initiated a climb."

Clearance amendment problems. - Frequency congestion was often reported as an associated element in airmen's misses of ATC call ups prefacing amended clearance instructions. Seventeen percent of all call sign incidents involved airmen's failures to respond to and comply with revised restrictions. The tenor of numerous controller reports indicated that pilots apparently tended to diminish listening attention once an expected clearance had been received. The airman protests were vehement: the amended instructions never had been received in the cockpit; no acknowledgement had been transmitted; why had not the controller caught the absence of the acknowledgement?

While some controller reports referenced workload and traffic volume as justifications for missed readbacks or acknowledgements, a surprising number of submissions merely noted the omission. "Later, I found out the pilot had never acknowledged for the clearance...", "The pilot never acknowledged the clearance and I didn't catch it...", "I cleared the small transport from 5000 to 4000 but I failed to notice that he did not acknowledge...". Overall, in this category of events, the absence of explanatory details suggested that the omissions of pilot acknowledgements were not considered as primary factors in the incident happenings.

The in-flight incidents of unacknowledged amended clearances were paralleled in taxi operations. The majority of these occurrences involved initial clearance to taxi to the runway with subsequent instructions during the taxiing to "hold short" of an intersecting or parallel runway. The compound failure in communications -- the airmen missed the call up, did not acknowledge the message and the controller failure to note the omission -- resulted in unauthorized crossing or entry into an active runway.

The airman explanations were firmly stated: no "hold short" reclearance messages had been heard and no acknowledgements for such instructions had been transmitted.

> "The tower said that they had told us to hold short. I missed that transmission..."

> * * * *

> "We never received or acknowledged for any clearance to hold short..."

> * * * *

> "After crossing, the tower asked if we had heard his 'hold short' clearance. We replied we had not."

> * * * *

> "The tapes confirmed that they had told us to hold short..."

> * * * *

> "If a clearance to hold short had been issued, it must have been blocked by other transmissions."

In this set of runway incursion reports, airmen identified two circumstantial factors pertinent to the missed ATC instructions. "Congestion on the frequency" frequently was cited: "With so much tower conversation going on, it is nearly impossible to hear all ATC transmissions". "Heavy radio communications" induced airman postincident speculations that the "hold short" message may have been blocked out during simultaneous transmissions.

Cockpit workload tasks also were mentioned in the narratives. Several air carrier flight crews specifically noted engine start-ups during taxi out as major distractions to radio attentiveness.

Several airmen suggested a procedural "fix" for "hold short" incidents involving communication failures:

1) Initial clearances to taxi should not state "to the runway" but only to the "hold short" position on the airport.

2) All pilots should be required to read back any "hold short" instructions. Controllers should listen to verify that such instructions have been received.

3) Only after such communication exchanges should an aircraft that could conflict with a crossing aircraft be released for takeoff.

Nonstop ATC transmissions. - "We pilots are triggered by our aircraft call numbers...". In this and in similarly phrased comments, airmen protested the insertion of multiple aircraft messages within a single, nonstop ATC transmission.

The "trigger" metaphor is an apt reference to a well-known self-disciplining process in psychologically conditioning airmen. All experienced pilots are familiar with it, develop it, and use it. Except for momentary spurts of attention -- to checklists, traffic watch, engine instruments -- pilots in manual flight direct their attentiveness to flying and "keeping ahead" of their aircraft. A full-time listening watch to continuous ATC voice traffic cannot be sustained. As a protective shield from communications distractions, pilots develop an aural shut-off, an on-off attentiveness that cycles with each new ATC transmission and is keyed open by the particular call sign of their aircraft. When an ATC transmission is initiated with another aircraft's call sign, the on-demand flow of attention is not activated. It will normally stay off until a subsequent ATC transmission is transmitted.

Run-on ATC messages -- instructions to one aircraft continuing without a break in transmission into multiple instructions to numerous other aircraft

12

-- evoked a series of pilot protest reports to the ASRS. "The controller issued instructions to 12 different aircraft, all in one, nonstop transmission...". "The controller was so busy that he had to talk continuously for up to 45 seconds a time...".

The nonstop transmissions were during rush hour, under big city terminal characteristics. The majority of pilot reports recognized the realities of congested traffic conditions with controllers directing aircraft mentioned specifically as 18, 20, and 22 in number. Compliments to the controllers for doing a good job under difficult circumstances were expressed frequently. However, the complimentary phrases invariably continued into the contradictory conjunction "but". "... BUT there was no opportunity for any pilot to acknowledge..." "... BUT (if) in the same message, (he) issues instructions to other aircraft, call signs may be missed," "... BUT controllers should not combine messages to different aircraft...".

Pilots were concerned with two gaps in this kind of cockpit/controller exchange of information: (1) the airman might miss his call up and, with it, his instructions and, (2) without the opportunity to acknowledge as prescribed in AIM[*], the controller would not know of any missed call up instructions.

Addressee Problems With Similar Sounding Aircraft Call Signs

"Aircraft call signs (may) have similar numbers/sounds or identical letters/numbers."

"Do not abbreviate similar sounding aircraft identifications..." (7110.65, Par 76).

"Emphasize appropriate digits, letters or similar sounding words to aid in distinguishing between similar sounding aircraft identifications. Additionally, (a) Notify each pilot concerned when communicating with aircraft having similar sounding identifications." Example. --

---

[*]AIM, 265: "Pilots of airborne aircraft should readback those parts of ATC clearances and instructions containing altitude assignments or vectors, as a means of mutual verification."

"United 31, United, ... Eastern 31 is also on this frequency..." (7110.65, Par 83).

"There was confusion as to who was who, with company Air Carrier 'A' and company Air Carrier 'B' both on the visual approach."

* * * *

"After we dived to avoid a pos: ble midair collision, we asked the controller for an explanation. He then stated that our clearance to climb had been for aircraft '245' and not for us, '345'."

* * * *

"It is a gross error on someone's part to allow call signs that are almost identical -- in this case, 'Baker 4' and 'Air Baker 44'."[*]

* * * *

"Before we hurt someone, this call sign problem has to be resolved!"

When "Porgy 128" and "Great Porgy 128" were simultaneously on the frequency -- or, AK31 with SK13, or, XYZ123 with XYZ132, or, ABC851 with ABC852 -- then the human factor errors mentioned in the Controller Handbook indeed "struck swiftly" and frequently during ATC/pilot communication exchanges.

Two hundred fifty incidents of similar aircraft call sign confusions were submitted to the ASRS during the approximate 4-year period. Similarities -- of sounds, of names, of letters and of numbers -- tricked the ears, the tongues, and the minds of both airmen and controllers. Nor were these instances of one-time happenstances of untimely coincidence: the majority of reports cited the similar call sign problems as chronic conditions imposed upon the ATC system through fixed, same-time schedules, hub traffic flow and main base terminal activities. Furthermore, controller reports cautioned that similar call signs were proliferating, as regional air carriers and air taxi services continued to displace wide-bodied aircraft with smaller transports flying multiple trips over confined, inter-city route pairs.

---

[*]All ASRS reports are completely deidentified. Similar aircraft call sign identifications in these quotations are representative only and have no relationship with any names or designators in actual use.

The numbers of incidents associated with similar aircraft identifications reflected, also, the dual vulnerability of pilots and controllers. Many types of mistakes can be made only by an airman in operation of his aircraft. Other inaccuracies are controller-only commissions or omissions. However, the aircraft call sign communication link could be broken at either end of the exchange: by the airman in misperception of his call up or by the controller, in transmission of a wrong call sign, call up of the wrong aircraft, etc.

The slip-ups in the transmission and/or acknowledgement of similar aircraft call signs fell into three separate sets of ambiguities.

- Similar sounding prefix names combined with similar or identical trip numbers/letters (e.g., "Baker 4" with "Air Baker 44").

- Identical airline, company, air taxi, or manufacturer prefixes combined with similar sounding or similar numbers/letters in trip or registration designators.

- Same, but differently ordered, digits in trip numbers or registration numbers/letters. This call sign similarity is intensified if (a) designator prefixes are dropped or (b) identical prefixes (manufacturer or company names) are present.

According to ASRS reports the error chains stimulated by these different manifestations of the similarity problem are somewhat different.

Similar prefix, similar alpha-numerics. - Many of the similar prefix incidents appeared to stem from a corporate "me-too" selection of designators, a subliminal marketing device that projected images of route service areas to prospective passengers.

As a traditional practice, air carriers always have tended to adopt those corporate names that visually and aurally delineated the geographical regions served by their schedules. The route-origin roots are still intact in such names as Eastern, Western, Alaska, Pan American, Hawaii, Northwest and similar geographic-oriented designators.

With the majority of U.S. geographical regions pre-empted by designators used by the established carriers, later entrants into Part 121 or 135 operations bridged scheduled service areas into corporate names by affixing a prefix or suffix to an airline designator already in use. Modifiers such as "North", "Air", "Royal", "South", "Express", etc., achieved this goal.

The mix of semi-identical prefixes inserted a set of extremely ambiguous call signs into the ATC communication network. A slurred initial transmission, a partially blocked call up, an abbreviated acknowledgement -- the sluff-over of but a syllable could misdirect an ATC clearance. "There have been many instances," stated one regional air carrier airman, "where the first word of our call sign has been clipped off so that it sounded like another carrier operating in this area". In other incidents the added-on prefix was duplicated in the call signs: "Our airline name is 'BCD Air', read another report, "and 'BCD Air' and 'CBD Air' sound similar. In this case, I believe the controller must have been talking to 'CBD Air'. Furthermore, controller transmissions at this airport are very rapid staccato..."

If the trip numbers of two aircraft using similar prefix designators were identical, then the potential for error was compounded. In the incident below, one such flight was taxiing in, after landing, while the second trip was taxiing out for takeoff.

> "We were 'Archer' flight 678 and after we heard 'Great Archer 678' also on the frequency, we all discussed in the cockpit the possibilities that might occur.
>
> "Then we thought we heard Ground Control clear us across the active, to expedite crossing. We thought the aircraft on final looked close in, so we hurried.
>
> "Half way across the runway, Ground Control told us that the clearance had not been for us but...".

Identical prefixes, similar alpha-numerics. - In the second category of similar aircraft call signs, the identifier prefixes were identical. Where this was true with regard to airlines, the incidents usually developed from the industry-wide practice of designating opposite direction flights between city pairs with odd-even trip numbers. However, these north-south, east-west directional indicators consisted of a single digit variation in the basic

16

series of numbers used to identify operational route areas (e.g., 60/61, 123/124, 811/812, etc.).

Airmen and controllers who became entangled in these one-digit differences in call signs vigorously protested the odd-even numbering system: "A dramatic effort should be made by every airline to avoid assigning similar digit numbers to trips arriving/departing major terminals...", "Airlines should eliminate similar call signs from aircraft arriving and departing an airport at the same time...", "We shouldn't permit similar flight numbered company trips to arrive at the same time...", "This call sign problem has to be resolved!"

The similar trip numbers produced similar incident patterns. Both trunk and regional air carriers were vulnerable:

> "XYZ123 was cleared to climb to 16,000 feet. Climbing through 5500, the departure controller called and asked, 'Where are you going?'.
>
> "Company XZY126 was also on the frequency so maybe we took his clearance."

* * * *

> "ATC issued us an immediate turn. Then the controller told us that the descent clearance had been for our company flight..."

* * * *

> "Every morning, this local airline has flights 123, 124, and 125 all operating at the same time. This a.m. I issued a climb clearance to 123 and the pilot of 124 took the clearance by mistake. From the tapes, it appears that 123 and 125 came within 100 feet of each other."

Controller reports displayed considerable umbrage and frustration at airmen who apparently forgot their own aircraft call signs.

> "Air Carrier ABC123 and ABC124 both arrive at this airport at the same time and on the same frequency. They should try to remember their trip numbers!!"

* * * *

> "This is a recurring problem at this airport. Commuter airline XYZ regularly adds on extra section flights, all using the same basic trip number. Example: 801, 801A, 801B, 801C, etc.
>
> "The flights all end up in trail, all on the same frequency. The pilots take clearances for the wrong aircraft, they forget if they are operating 'A' or 'B' or 'C' or the basic flight....
>
> "The situation is not only confusing but has potential for a real problem!"

The airmen's narratives permitted some empathetic understanding of their misplaced call sign identify. In short haul operations, pilots frequently operated several odd/even numbered trips during a one-day schedule pattern. In longer trip cycles, the airmen operated a repetitive series of back-and-forth round trips within a bid block of time. Habit-conditioned, in outbound flight to one call sign, the flight crews admittedly forgot, at times, after turn-around, that they were operating a similar but different trip number in the opposite direction. In one incident report, a pilot confounded a series of ATC controllers by filing his flight plan, taxiing and taking off, still using the inbound trip number of the previous flight.

The identical-prefix-similar-trip-number airline call signs were paralleled in various air taxi and General Aviation operations. These two activities tended to cluster at individual airports, the air taxis with multiple, consecutively numbered aircraft call signs and light planes, with the same manufacturer prefix, doing repetitive takeoff and landing practice in the pattern.

> "I was 123Kilo but the Ground Controller apparently mixed me up with 124Kilo taxiing out behind me. It became very confusing..."

* * * *

> "There is a flight school on this airport. We have a problem that is both ludicrous and unsafe when 3 or 4 low-time pilots, all with the school's similar call sign aircraft, are operating around the field."

* * * *

"The reason that I'm writing this is because it happened
to me twice in the same day. I was giving flight
instruction in an XXX type trainer with an aircraft with
the same manufacturer name also in the pattern. I was
able to keep things straightened out but I wonder how
students, alone in the plane, would make out in such con-
fusion of call signs."

Same digits, differently ordered. - The third category of aircraft call
sign similarity fostered transposition errors. Usually, these slips-of-the-
tongue consisted of misordering identical sets of digits. In appearance, the
call sign "ABC581" may not be similar to a call sign such as "ABC851"; yet,
in repetitive incidents, controllers and airmen confused such numerical
sequences during communication exchanges.

"The center apparently intended to tell XYZ4123 to main-
tain one three thousand. Instead, he got us confused
with them (XYZ123) and issued it to us."

* * * *

"We heard the Center calling ABC143 four times. We did
not answer these calls. Later, I came to believe that
she had been trying to reach us (we were ABC123)."

* * * *

"When aircraft C suddenly called in on the frequency, the
controller trainee became flustered. This resulted in
his calling C by another name in several call ups. C did
not acknowledge these calls.

"A and C were on collision courses until A pilot saw the
traffic and took evasive action."

Hurried, "panicky" transmissions were particularly vulnerable to
transposed call sign errors. Controller training appeared as a background
causal factor in some incidents; in others, hasty messages during emergency
situations were misdirected to the wrong aircraft.

"The computer locked up and seized in position. For one
minute and twenty seconds there was no computer or DARC
display. No data blocks moved.

"When the radar display resumed, I saw 2 air carriers,
head-to-head, opposite direction, same altitude.

19

"I issued an immediate descent clearance but in my
excitement I transposed call signs and issued the clear-
ance to a third aircraft on the frequency.

"The 2 air carriers passed each other, both level at
FL280."

* * * *

"I was setting max takeoff power when I heard a garbled
transmission referring to 'Air Carrier XXX' (our call
sign). Shortly thereafter, I clearly heard a call, 'XXX,
your right engine is on fire!!'

"I immediately aborted the takeoff..."

* * * *

"The trainee arrival controller saw the conflict develop-
ing and issued a heading change. However, he used the
wrong call sign and the Navy jet ignored the turn
instructions. At this time, the 2 aircraft were rapidly
closing...the instructor controller told the military
trainer to climb! and then repeated the transmission.
The pilot applied full power, commenced a zoom climb and,
on breaking out of IMC, saw the light twin as it passed
by."

Airman Acknowledgement/Readback Errors; or, Is Anyone Listening Up There?

"(Airmen) should acknowledge all call ups and clear-
ances..." (AIM, Chapter 192(c)).

Throughout the study, controller narratives expressed frustration,
chagrin, and, at times, outright dismay, at airmen's apparent inattentiveness
to ATC transmissions. Pilots missed their aircraft call ups, took clearances
for other aircraft, frequently failed to respond and comply with clearance
amendments and, in general, were "tuned out" when busy, congested traffic
conditions clogged the frequencies.

"I must have noticed that G.A. and most corporate pilots
need to be called two or three times before responding to
the first call up."

* * * *

"Time is very important to a controller. I suggest that pilots be required to maintain a better listening watch on the frequency."

* * * *

"The Center advised, 'We would appreciate your listening more to your clearances.' We rogered and apologized..."

* * * *

"The breakdown in communication came from the age old problem of not listening. Had the pilot been paying attention..."

The pilot communication failures were frequent enough to elicit various controller "So what else is new?" resigned responses to apparent airman inattentiveness. "It happens so frequently, it becomes commonplace...", "Flight crews are not paying enough attention...", "Cause of incident? Pilot apparently not listening...", "Another listening lesson...", "If pilots paid more attention, they would not err so frequently...", "I called four times in the space of one minute, without response...".

Numerous conflict incidents apparently substantiated controller unfavorable comments concerning pilot monitoring of ATC communications:

> "At this time, aircraft ABC was cleared to FL350 so as to pass above aircraft XYZ. However, CBC took ABC's clearance and started climb. After about a minute, ABC was observed on radar still at his previous altitude and was given a turn to avoid XYZ. Three or four calls were required to get his attention...

> "Then the altitude readout of CBC was observed. He confirmed he was climbing and then ABC reported that he was taking evasive action to miss an aircrat ahead of him at the same altitude...

> "The incident was caused by the pilot's not listening carefully enough..."

Error Involving Controller Confirmations
of Acknowledgements/Readbacks; or,
Is Anyone Listening Down There?

"The readback...serves as a double check between pilots
and controllers and reduces the kinds of communication
errors that occur when a number is either 'misheard' or
is incorrect." (AIM, Chapter 265)

"If we are required to make readbacks, it would seem that
it should be a controller's responsibility to listen to
them."

*   *   *   *

"My point is this: what is the value of readbacks if no
one on the other end is listening?"

*   *   *   *

"Either due to workload or surroundings, the controllers
do not seem to hear aircraft replies..."

The most obvious, the most repetitive, and perhaps the most significant
deficiency identified in the reported call sign incidents was the failure of
a controller to listen to a pilot's acknowledgement or readback of an ATC
clearance message.

The problem seemed endemic: in the reported picture, controllers were
not listening.

The airmen were puzzled by it: why their responses apparently were
ignored, why their communication mistakes passed unchallenged through a sup-
posedly fail-safe verification process. Forty-two percent of the reported
incidents of pilot errors in call sign acknowledgements specifically noted
that controllers had failed to catch the cockpit mistakes. Pilots expressed
their bewilderment at the failure of the double-check system in direct terms:
"Someone is not listening...", "Somebody is not listening...", "Why the con-
troller did not correct us on our readback is unknown...", "I suggest that
controllers listen to flight crews to verify...", "The controller made no
correction to my readback...", "Sometimes you don't even get a mike click to
verify an acknowledgement...", etc., etc.

22

Furthermore, some reporting controllers admitted such readback misses: "For some reason I did not catch...", "I failed to hear...", "I did not pay attention to...", "The controller did not realize the wrong aircraft had acknowledged...", "For whatever reason, I did not hear...", "Due to another aircraft on a missed approach, I did not hear...". The type of facility, the workload conditions and the distraction elements varied extensively, but the "I did not hear" phraseology remained a constant in the reports. Other controller reporters were more ambivalent in their self-assessments of blame for incidents resulting from an airman's error in call sign response. There was considerable emphasis on pilot responsibility: "If the pilots paid more attention, they would not err so frequently". Similarly themed observations implied that the verification role in readback confirmations was merely a secondary procedural step. The irony in the situation was obvious to them: their mistakes consisted of failures to catch and correct airmen's errors. "I'm the one stuck with the job of correcting other people's mistakes", lamented one controller, "If I don't hear it, then I'm the one who gets the blame!"

The controllers' cause-and-effect logic was valid: in the ASRS reports, their monitoring failures were not the primary causal agents for the hazardous occurrences. The enabling errors were elsewhere: in airmen's misperceptions, in "guessed at" aircraft identifications, in mental slip-ups and in half-blocked transmissions. Yet, the missed verifications of pilot acknowledgements and readbacks appeared to represent more than just another, different set of human factor inconsistencies and limitations. From any procedural viewpoint, and certainly in the view of the airmen, the unmade confirmations constituted a breakdown of a basic system concept. The failure of the procedural mechanism not only represented a second error, but the silent acquiescence conveyed a false sense of security to the airmen that someone had listened and someone had verified their responses as correct.

The majority of controller narratives did not elaborate upon any causal "why" or circumstantial "how" of missed confirmations of airman acknowledgements/readbacks. This absence of explanatory detail may be due, in some measure, to the type of error involved in the communication exchange: errors of omission are not immediately obvious and are seldom self-

recognized. Frequently, the double error was detected only in after-the-fact running of the tapes in incident investigations. Overall, the controller narratives portrayed their communication role as a short-spanned attentiveness to multiple aircraft: any deficiencies in listening to pilot responses were enveloped in frequency congestion and in the rapid-fire pace of communications during heavy traffic conditions. The reports clearly indicated that these conditions did not permit time for call up-pause, call up-pause, call up-pause sequencing intervals in voice communications.

Analysis of these controller submitted reports led to an inference on the part of the analysts that, perhaps subconsciously, controllers were allowing radar moitoring to replace readback confirmations in ATC/cockpit communication exchanges -- especially during congested traffic conditions.

The majority of the reports confirmed that pilot communication errors -- whether consisting of unheard ATC transmissions or misread call sign responses -- were caught by radar observations of unauthorized deviations from clearance instructions. This seeming reliance on radar surveillance as the double-check mechanism in communications resulted in the pilot errors being intercepted, but only after the erroneous actions had been initiated so the aircraft was already out of the intended flight path.

Also, this apparent utilization of radar monitoring as sole confirmation of complete and correct communication opened the door for coincidental event chains not directly related to the communication failure to interact detrimentally. A radar computer failure, a tag drop, an aircraft transponder not turned on or intermittent in operation, misread instructions that included frequency changes and attention directed elsewhere on the radar scope -- such system and human factor elements became causal agents for operational anomalies rooted in communication failures. Eight percent of the call sign incidents reflected inadequacies in radar surveillance when utilized as the confirmation step in ATC/pilot communications.

Furthermore, pilot expectation that ATC/cockpit communication exchanges will normally consist of three to/from links is not supported by current FAR, AIM, or controller handbook regulations. All of these authoritative guides

indicate that heavy traffic conditions and congested voice frequencies have been recognized as having the power to disable the three-step procedure.

1) There is no FAR regulation or specified procedure that <u>requires</u> pilot acknowledgement of clearances or instructions. There is no controller responsibility to confirm such pilot acknowledgements/readbacks.

2) The controller's Handbook lists no formal duties or responsibilities for controllers to monitor pilot acknowledgements/readbacks.

3) The AIM contains only oblique references to the responsibilities of pilots and controllers; the phraseology suggests rather than mandates that:

    a) "Pilots should readback those parts of clearances that contain altitude assignments or vectors..."

    b) "...such readbacks serve as a double check...and reduce errors..."

Perhaps the responsibilities of monitoring and confirmation of transmissions as correct are assumed duties, too obvious for statement in official publications. However, the absence of specific responsibilities, the nonuse of imperatives such as "must" or "shall", tends to indicate that readback confirmation is a best-effort option rather than a fixed, inflexible duty requirement.

SUMMARY

Communication errors involving aircraft call signs were portrayed in reports of 462 hazardous incidents voluntarily submitted to the ASRS during an approximate 4-year period. These reports described occurrences wherein ambiguities, misperceptions, and missed call up transmissions or acknowledgements resulted in confusion, disorder, and uncoordinated traffic conditions. Specific operational results were altitude deviations, wrong-way headings, aborted takeoffs, go arounds, runway incursions, missed crossing altitude restrictions, descents toward high terrain, and a melange of near-collision traffic conflicts in flight and on the ground.

Analysis of the report set resulted in identification of five categories or errors involving call signs: 1) faulty radio usage techniques, 2) call sign loss or smearing due to frequency congestion, 3) confusion resulting from similar sounding call signs, 4) airmen misses of call signs leading to failures to acknowledge or readback, and 5) controller failures regarding confirmation of acknowledgements or readbacks.

Perhaps the most significant of the study findings concerned the double error sequencies in the last of these five categories: the incidents in which an airman acknowledged and complied with ATC instructions intended for another aircraft, followed by controller failure or delay in detecting the misperception. The errors of commission and omission are equally culpable in the normal routine of ATC/cockpit communications. However, the deeper insight obtained from the study regarding the airmen's apparent belief in the fidelity and reliability of the three-step communication protocol versus the controller's apparently less rigorous practice of it (including the possibility of his substitution, on occasion, of radar monitoring) led to these conclusions regarding ATC/cockpit communication procedures.

- During busy, congested frequency conditions, airmen should consider controller confirmation of their acknowledgements/readbacks as a "best" effort" action rather than a procedural requirement in communications.

- An airman should not assume that routine readback of a "doubtful" clearance or instruction is adequate for verification purposes. A separate "verify..." transmission questioning the uncertain elements in the message always should be made.

Misperceptions of similar aircraft call signs comprised slightly more than half of the call sign incidents retrieved. Although procedures for mitigating this hazard are set forth in various chapters of the AIM and the Air Traffic Control handbook, both airmen and controllers demonstrated human factor vulnerability to error in the presence of similarities in sounds, letters, numbers and digits in aircraft designators. The reporter submissions seldom noted the issuance of an ATC advisory message stating that similar aircraft call signs were on the frequency. Those reports that mentioned receipt or transmission of an advisory notice indicated that the similarity

26

consisted of identical trip numbers. The controller handbook also exempli-
fies the need for the advisory with identical flight designators: thus,
"American thirty-one, Eastern thirty-one also is on the frequency...". This
narrow illustration of similarity may be a limiting factor in controller
recognition of other, less obvious combinations of phonetic similarities.
The hazard would be greatly reduced if:

- Airlines did not utilize an odd/even numbering system for
  opposite direction flights when such trips are scheduled
  for simultaneous or near-simultaneous arrivals/departures
  at individual terminals.

- Extra section airline or air taxi flights were not tagged
  with the same trip numbers when operating in the same
  time periods.

- New airlines that have formed corporate designators by
  addition of a prefix or suffix to names of established
  airlines already operating in the same geographic route
  areas (e.g., "Air", "Great", etc.) would adopt a dif-
  ferent call sign for communication purposes (e.g., Pan
  American utilizes a "Clipper" prefix, thus avoiding simi-
  larity with American Airlines).

- Airmen and controllers, were to avoid the practice of
  dropping prefixes in aircraft designators thus reducing
  the number of dissimilar characteristics in call sign
  transmissions and thereby increasing the potential for
  similarity in trip or registration letters/numbers.

Seventeen percent (78 incidents) of the call sign message failures con-
sisted of apparently unheard and unacknowledged amendments to previous ATC
clearance instructions. The majority of in-flight occurrences represented
missed "Maintain____" revisions to previously issued clearances to
climb/descend to higher/lower altitudes. The on-the-ground, taxiing events
were related to "hold short" messages issued subsequent to the initial clear-
ance to the runway. The airmen failures to hear these ATC amendments fre-
quently appeared to demonstrate displacement of listening attention by higher
priority duties. Additionally, the overlapping mix of high/low priorities
was interwoven with an apparent low level of cockpit expectancy for any
amendments to previous, acknowledged-for clearances. This hazard would be
reduced if:

27

- Controllers were to be especially alert for "hear-back" of airman acknowledgements of <u>amended</u> clearance instructions.

- Consideration were given to requiring acknowledgements and confirmations of acknowledgements for "hold short" instructions during taxiing. This particularly applies to multiple runway operations.

Frequency congestion was a factor in call sign communication problems through the entire range of incident occurrences. Simultaneous transmissions obliterated aircraft call signs, induced misperceptions, blocked transmissions and acknowledgements and contributed to call sign similarities during all phases of flight operations. The most effective means of mitigating this complex hazard appears to be the introduction of data link technology which is scheduled as part of the current "National Airspace Plan". Pending such introduction, control of the hazard will depend mainly on the further development of skill and devotion in adhering to sound procedures on the part of all participants in aviation communications exchanges,

Throughout the set of call sign reports, one repetitive phrase characterized both controller and airmen narratives. This typical expression could be generally stated as: "I figured it out later, how it all must have happened..." The inability to comprehend immediately what was happening — or why it was happening — epitomized the hazardous nature of call sign errors in ATC/cockpit communications. If not immediately caught and corrected, call sign mismatches often plunged the airman into confusion and the aircraft into hazard. As the AIM warns, the communication link between pilot and controller, once broken, may result in disastrous consequences.