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LANGUAGE-RELATED MISCOMMUNICATIONS AND MISUNDERSTANDINGS IN PILOT/CONTROLLER COMMUNICATIONS

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List of Abbreviations

AIM – Airman's Information Manual

ASRS – Aviation Safety Reporting System

ATC – Air Traffic Control

ATCO – Air Traffic Controller

EGP – English for General Purposes

ESP – English for Specific Purposes

EUROCONTROL – European Organization for the Safety of Air Navigation

FAA – Federal Aviation Administration

FL – Flight Level

IATA – International Air Transportation Association

ICAO – International Civil Aviation Organization

ILS – Instrument Landing System

IPA – International Phonetic Alphabet

ITU – International Telecommunication Union

NASA – National Aviation Space Agency

NATO – North Atlantic Treaty Organization

NTSB – National Transportation Safety Board

PRICESG – Proficiency Requirements in Common English Study Group

RP – Received Pronunciation

RT – Radiotelephony

RVR – Runway Visual Range

VMC – Visual Meteorological Conditions

ABSTRACT

The prime aim of this paper is to discuss some common language-based errors and misunderstandings that arise from using voice-mediated language as the medium of communication between pilots and air traffic controllers. This paper also provides a phonological analysis of standard radiotelephony phraseology and emphasizes the importance of clear, accurate and unambiguous pilot/controller dialogue.

The following topics are covered: language and aviation safety, English use in aviation communication, ATC phraseology, nature of ATC communications, and language-based errors and communication problems.

Voice communication problems can result in hazardous situations. Various incidents and accidents are cited in which poor language proficiency was identified as a contributory factor.

Three distinct areas of language use that form the basis of language proficiency for safe communications are: ATC phraseology, English for Specific Purposes (ESP) and English for General Purposes (EGP). The descriptors of level 4 measure the ability to communicate in what ICAO terms plain language, in order to make a clear contrast with the air traffic control phraseology suitable for routine situations.

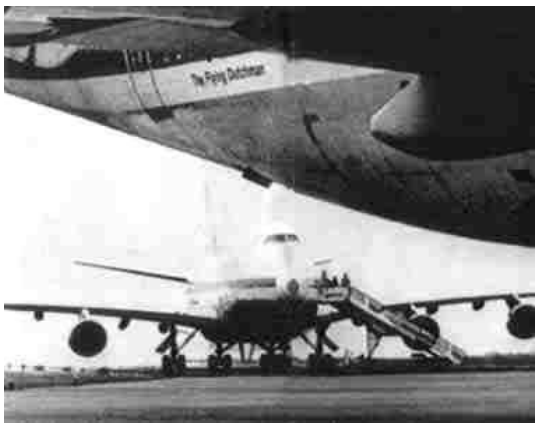
In order to provide a linguistic analysis of language-related problems and misunderstandings in pilot/controller communications I used a method of accident data and post accident analysis, such as National Transportation Safety Board (NTSB) data base. Some of the data presented here are taken from the monthly bulletin *Callback*, published by the Aviation Safety Reporting System (ASRS) of NASA-Ames Research Centre.

INTRODUCTION

"Words differently arranged have a different meaning, and meanings differently arranged have different effects"

Pascal

On March 27, 1977, a KLM and Pan Am 747 collided on a crowded, foggy runway in Tenerife, the Canary Islands. The pilot of a KLM Boeing 747 radioed, "We are now at take-off", meaning that the plane was lifting off as his aircraft began rolling down the runway. The air traffic controller misunderstood and thought the plane was waiting for further instructions on the runway, and so did not warn the pilot that another aircraft, a Pan American Airways B747 that was invisible in the thick fog, was already on the runway. The resulting crash killed 583 people in what is still the most destructive accident in aviation history.



This picture was taken at the Tenerife airport, a few minutes prior to the crash. It shows both 747 that will collide in a few minutes. Foreground, the KLM one. Background, the PanAm one.

For many years it has been recognized that communication problems are implicated in many aviation accidents and in runway incursions.[1] In this fatal aviation accident in Tenerife, the Canary Islands, and in all other instances involving language miscommunications, a better understanding of the English language on the part of the flight crew and/or air traffic controllers could have possibly prevented the accident.

[1] A runway incursion is the unauthorized entry onto a runway by an aircraft, a vehicle, a person or an object.

Recent analyses of aviation incidents and accidents throughout the world have increasingly drawn attention to the contributing role of imperfect pilot-controller communications.

Around 75% of fatal airline accidents involve planes that are technically able to be flown and landed safely (Taggart 1994). Usually the concern is not so much one of pilots' individual competence, their technical knowledge or ability to control their plane, but the way the pilots communicate and act as a crew in specific circumstances, for example, to share information, assess situations, and make decisions (Cushing 1994).

O'Hare and Roscoe (1994) point out that although the vast majority of flights operate smoothly and without incident, misunderstandings between air traffic controllers and pilots have played a major role in a number of accidents. According to some reports out of the six accident scenarios, five of them had implications of pilot/ATCOs miscommunications.

A first step towards reducing the incidence of communication problems is to understand why and how they happen. It is also beneficial to effectively learn and study the causes in order to prevent a future tragedy.

1. LANGUAGE AND AVIATION SAFETY

The importance of communication in an air traffic system was emphasized by Linter and Buckles (1993), who stated that "Regardless of the level of sophistication that the air traffic system achieves by the turn of the century, the effectiveness of our system will always come down to how successfully we communicate".

There are numerous findings noting the crucial nature of communication in aviation safety. Flight Safety Information (2004: 12) reports that "Between 1976 and 2000, more than 1100 passengers and crew lost their lives in accidents in which investigators determined that language had played a contributory role."

The Federal Aviation Administration (2004) estimates that human error is a contributing factor in 60-80% of all air carrier incidents and accidents, citing ineffective communication and other communication-related indicators as underlying causes of such human error.

The most frequently mentioned accidents in which language-related miscommunications were a crucial contributing factor occurred in Tenerife in the Canary Islands on March 27, 1977, Cove Neck, New York en route to JFK on January 25, 1990, and the mountainous terrain near Cali, Colombia on December 20, 1995.

The accident that occurred at Cove Neck, New York, on 25 January 1990 resulted in part from the fact that the copilot used the normal English phrase *running out of fuel* rather than the technical aviation term *emergency*, thereby failing to convey to the controller the intended degree of urgency (Cushing 2004: 2).

Nordwall detailed the crash of American Airlines Flight 965 near Cali, Columbia in December 1995, as an example of a controller's inability to communicate effectively in English. W. Frank Price, manager of air traffic services international staff for the FAA said, "Had he [the controller] been able to do so [communicate the crew's position in English], it could have contributed to the crew's situational awareness - a factor that might have prevented the accident" (Nordwall 1997: 46-51).

Verhaegen noted the 1996 crash near Delhi, India which involved a Boeing 747 and an Ilyushin Il-76 was due to miscommunication amongst two foreign flight crews. Neither crew was reported to have a high level of proficiency in English. The accident inquiry revealed that there was confusion about the level to which the freighter Il-76 was cleared to descend (Verhaegen 2001: 15-17).

What these seemingly different types of accidents had in common was that, in each one, accident investigators found that insufficient English language proficiency on the part of the flight crew or a controller had played a contributing role in the chain of events leading to the accident.

1.1. ENGLISH USE IN AVIATION COMMUNICATION

Language problems at the heart of a large number of disasters and near-disasters have prompted ICAO[2] to establish stringent new language standards intended to significantly improve and maintain the English language proficiency of aviation professionals. The ICAO mandate specifies that in order to stay operational after March 2008 (recently extended to 2011), all pilots and air traffic controllers working international routes must demonstrate a high level of fluency not only in Aviation English specific phraseology, but, importantly, also in general English – with an emphasis on oral skills.

In addition to strengthening the provisions related to language use in radiotelephony communications, ICAO has also established a language proficiency rating scale delineating six levels of language proficiency ranging from Pre-elementary (Level 1) to Expert (Level 6) across six areas of linguistic description: Pronunciation, Structure, Vocabulary, Fluency, Comprehension & Interactions. The minimum operating level of English-language proficiency will be ICAO Operational Level 4 (ICAO Document 9835, 2004).

[2] The International Civil Aviation Organization (ICAO) the United Nations affiliated body responsible for setting safety standards for air transport chose English as the official language of aviation. The Fourth COM Division which met in April 1951 established the following principle: **...** the English language ***should be*** the basis for the development of the requisite phraseologies." (ICAO PRICESG/1-SN/8 10/11/00)

Pronunciation needs to be sufficiently clear and assumes a dialect and/or accent intelligible to the aeronautical community. Controllers and pilots require sufficient **vocabulary** to be able to communicate in both the routine and non-routine situations which may occur in their jobs. In addition, controllers and pilots need to have a good command of basic **grammatical structures** so that they can communicate information in a format which will be understood by their interlocutor. Effective communication requires active and intensive **listening** by all parties involved, concentrating on each part and word in order to fully understand the whole message. A certain degree of **fluency** is required because controllers have to communicate with several aircraft at the same time and they cannot wait for an unreasonably long time for a pilot to pass a message. Pilots need to receive information and instructions in good time to react accordingly. The **interaction** between pilots and controllers must be effective, as both parties need to be able to check, confirm and clarify when misunderstandings occur (Emery & Roberts 2008: 4).

Communicative competence in aviation English means that airmen have common and standardized proficiency levels in the following three critical components: highly specialized ATC phraseology, ESP as it applies to aviation, and the foundational EGP.

The core language of aeronautical communication between pilots and air traffic controllers is known as *standard radio-telephony phraseology*, a set of phrases or a 'code' which is used in routine and most emergency situations. The manual on standard phraseology can be simply memorized. Through repetition on a daily basis, controllers and pilots can become highly proficient in their use of phraseology.

Besides mastery of the standard phraseology, pilots and controllers also need to acquire *specific aviation vocabulary* which Orr defines as "specific subsets of the English language that are required to carry out specific tasks for specific purposes." ESP consists of vocabulary and concepts which are "unfamiliar to most native and nonnative speakers and thus require special training" (Orr 2002: 1).

In the following examples, common English words such as *base*, *three o'clock*, and *clear* have aviation-specific meanings.

- ✈ Turn base now, follow traffic at your three o'clock, cleared for the option.
- ✈ Remain clear of Class Charlie airspace, contact approach on one two three decimal six five.

The problem is that a good knowledge of phraseology, which is appropriate for exchanging expected routine messages, is not sufficient to deal with a non-routine situation when an unusual or an unexpected situation might cause confusion. A non-routine situation may also be an emergency situation, or have the potential to develop into an emergency situation. The only way that pilots and controllers can be sure to be able to communicate in a non-routine situation is if they both have a sufficient level of proficiency in the English language.

ICAO Level 4 competency[3] means that aviators possess reliable English language skills that can withstand the most unpredictable and stressful of situations.

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[3] **ICAO RATING SCALE, LEVEL 4: OPERATIONAL**

Pronunciation
Pronunciation, stress, rhythm, and intonation are influenced by the first language or regional variation but only sometimes interfere with ease or understanding.

Structure
Basic grammatical structures and sentence patterns are used creatively and are usually well controlled. Errors may occur, particularly in unusual or unexpected circumstances, but rarely interfere with meaning.

Vocabulary
Vocabulary range and accuracy are usually sufficient to communicate effectively on common, concrete and work-related topics. Can often paraphrase successfully when lacking vocabulary in unusual or unexpected circumstances.

Fluency
Produces stretches of language at an appropriate tempo. There may be occasional loss of fluency on transition from rehearsed or formulaic speech to spontaneous interaction, but this does not prevent effective communication. Can make limited use of discourse markers or connectors. Fillers are not distracting.

Comprehension
Comprehension is mostly accurate on common & work-related topics, when the accent or variety used is sufficiently intelligible for an international community of users. When the speaker is confronted with a linguistic or situational complication or an unexpected turn of events, comprehension may be slower or require clarification strategies.

Interactions
Responses are usually immediate, appropriate & informative. Initiates & maintains exchanges even when dealing with an unexpected turn of events. Deals adequately with apparent misunderstandings by checking, confirming, or clarifying.

Plain English (or English used in non-routine situations) in pilot/controller communications needs to be clear, unambiguous, free of colloquialisms, idiomatic speech and slang. Below are two messages in plain English:

'I have a flat tyre on the nose gear.'

'We are having problems with the hydraulic systems.'

1.2. AIR TRAFFIC CONTROL PHRASEOLOGY

When pilots and air traffic controllers speak to one another in the professional context, it usually takes place in prescribed, coded language, called **ATC phraseology** (also known as **radiotelephony**).

Crystal (1997) described registers such as "Seaspeak" for maritime use and limited phraseology for Air Traffic Control called "Airspeak". Both of these abbreviated means of communicating have military roots linked to the limited radiotelephony employed for transmitting interactions. Much like military protocols, maritime and aviation phraseologies employ succinct, prescribed interactions in which all parties involved know the expected turn taking. Anticipated responses and read-backs help clarify directives and expedite procedures (Laird 2006).

Aviation English is not a natural language. Ragan (2002) refers to aviation English as "Airspeak" which he characterizes as "idiosyncratic, predictable, and yet problematic in communicating meaning." Aviation communications consultant, Marsha Hunter conveyed:

> ...aviation phraseology doesn't necessarily follow the linguistic rules we have hard-wired into our brains. One theory of human language postulates that verbs and nouns fall in certain places in sentences, and that all human languages follow the same basic rules. Aviation phraseology is a technical language concocted by humans, not a language which has evolved over millennia. Clearances don't necessarily follow hard-wired linguistic rules, so we may have to think a few extra seconds to process what we've heard before we respond. We can learn to use invented technical languages, but it takes practice" (Hunter & O'Brien 2002).

Airspeak uses the standard English language as its basic structure but focuses solely on communicative needs in aviation. Standard English has been

modified on many linguistic levels: phonetic, syntactic, morpho-syntactic and semantic in order to improve ATC flight communications and to ensure intelligibility of voice signals over radio links.

All the prescribed and predetermined expressions used in this context are self-contained and limited to the set sanctioned by the appropriate aviation authority. For example, The Air Traffic Controllers' Handbook, 7110.65 (Air Traffic Control Services, The Federal Aviation Administration), contains extensive listings of words, phrases, and sentences to be spoken in a myriad of situations, e.g.:

- ✈ Runway two seven, cleared for take-off.
- ✈ Traffic, ten o'clock, one two miles, southeast bound, one thousand feet below you."

"The phrases used in the radiotelephony context are designed to make the pilot/controller communication as concise and brief as possible, with the emphasis on accurate content as opposed to linguistic form. The brevity and conciseness of the communication is accomplished partly by using formulaic and predetermined sentence fragments" (Mitsutomi & O'Brien 2002: 6). For instance:

- ✈ American Airlines flight 54, turn left heading 100, intercept the localizer and proceed inbound, cleared for the ILS approach to 13 Right, maintain 2,200 until established. Contact tower on 120.6 at NOLLA.

In these examples you can note that the sentence fragments are usually simple imperative clauses: they do not have a subject, but a predicate in the form of imperative (i.e. the bare infinitive form of the verb). If the passive is needed, only the past participle is used, e.g. cleared for take-off; report established on the localizer. For instance:

- ✈ Fastair 345 cleared straight in ILS approach runway 28, descend to altitude 3000 feet QNH 1011, report established on the localizer.

There is an absence of grammar, complexity, words that are difficult to pronounce, words with ambiguous meanings, etc.; grammatical markers, such as determiners (the/a), pronouns, prepositions and auxiliary verbs are deleted.

Unlike conversational English, aviation English is often disjunctive, without contracted forms and genitive constructions. Speech is broken up into units, often with a pause between them.

Aviation English is very dependent on context and a shared phraseology. ATC speech is often unintelligible to the outside listener because it is based on a lexicon of standard words and expressions, abbreviations and acronyms; even if the words can be understood, they do not make much sense without the knowledge of the air traffic control task.

This is an example of RT phraseology (Jeppesen 2004) and its translation into Plain English:

London Control Clears **Golf Bravo Echo Juliet Victor**
to join controlled airspace at – route **Golf Wun** Flight Level
Ait Zero squawk 3217 contact London now frequency
Wun Too Tree Day-se-mal Fower.

In this message the words with **specific aviation meaning** are:

- **clear** – give official permission for an aircraft to proceed under conditions specified by Air Traffic Control unit
- **controlled airspace** – an airspace of defined dimensions within which Air Traffic Control service is provided
- **squawk** – operate radar beacon transponder on designated code

ICAO phonetic alphabet is used for:

- ✈ aircraft identification: **Golf Bravo Echo Juliet Victor = GBEJV**
- ✈ route: **Golf Wun = G1**
- ✈ Flight Level: **Ait Zero = 80**
- ✈ frequency: **Wun Too Tree Day-se-mal Fower = 123.4**

Plain English

London Air Traffic Control gives aircraft GBEJV permission to enter controlled airspace – on the route G1, Flight Level 80. Activate transponder 3217 and contact London immediately on frequency 123.4.

Of the many factors involved in the process of communication, phraseology is perhaps the most important, because it enables pilots and controllers to communicate quickly and effectively despite differences in language, and reduces the opportunity for misunderstanding.

1.2.1. Standard Words and Phrases

Here is a list of commonly used words and phrases which should be used in radiotelephony communications as appropriate and shall have the meaning shown below (Jeppesen 2004).

WORD/PHRASE	MEANING
Acknowledge	Let me know that you have received and understood this message.
Affirm[4]	Yes.
Approved	Permission for proposed action granted.
Break	I hereby indicate the separation between portions of the message. (To be used where there is no clear distinction between the text and other portions of the message)
Cancel	Annul the previously transmitted clearance.
Check	Examine a system or procedure. (No answer is normally expected)
Cleared	Authorized to proceed under the conditions specified.
Confirm	Have I correctly received the following....? or Did you correctly receive the message?
Contact	Establish radio contact with….
Correct	That is correct.
Correction	An error has been made in this transmission (or message indicated). The correct version is.....
Disregard	Consider that transmission as not sent.
Go ahead	Proceed with your message. *Note: The phrase "Go ahead" is not normally used in surface movement communications.*
How do you read?	What is the readability of my transmission?
I say again	I repeat for clarity or emphasis.
Monitor	Listen out on (frequency).
Negative	No or Permission not granted or That is not correct.
Out	This exchange of transmissions is ended and no response is expected.
Over[5]	My transmission is ended and I expect a response from you. *(The word "OVER" is not normally used in VHF communications)*

[4] **Affirm** is used instead of affirma**tive** in order to avoid confusion with nega**tive** in RT communications.

[5] Once satisfactory two-way contact with an aircraft has been established, controllers are permitted to shorten the procedures and phrases such as 'over', 'roger' 'out', may be omitted.

Read back	Repeat all, or the specified part, of this message back to me exactly as received.
Recleared	A change has been made to your last clearance and this new clearance supersedes your previous clearance or part thereof.
Report	Pass me the following information.
Request	I would like to know or …I wish to obtain.
Roger[6]	I have received all of your last transmission. *Note: Under no circumstances to be used in reply to a question requiring "READ BACK" or a direct answer in the affirmative (AFFIRM) or negative (NEGATIVE.)*
Say again	Repeat all, or the following part, of your last transmission.
Speak slower	Reduce your rate of speech.
Standby	Wait and I will call you.
Verify	Check and confirm with originator.
Wilco	(Abbreviation for 'will comply') I understand your message and will comply with it.
Words twice	a) As a request: Communication is difficult. Please send every word or group of words twice. b) As information: Since communication is difficult, every word or group of words in the message will be sent twice.

Use of established **standard ICAO phraseologies** for radiotelephony communication between aircraft and ground stations is essential to avoid misunderstandings and to reduce the time required for communication. Use of standard words and phrases also increases intelligibility since it increases the frequency with which a word is used in a specific situation. Their familiar use and expectation reduces ambiguity in communication (IATA 2004).

ICAO phraseology shall be used in all situations for which it has been specified. When standardized phraseology for a particular situation has not been specified, plain language shall be used (ICAO Annex 10 Volume 11 par. 5.1.1.1).

[6] Roger" was the U.S. military designation for the letter *R* (as in received) from 1927 to 1957. The first citation given by the *Oxford English Dictionary* for "roger" in the sense of "received" dates from 1941, coinciding with U.S. entry into WWII. The term made the big time in 1943, when the Army Signal Corps incorporated it into one of its procedural manuals. In 1957 "Roger" was replaced by "Romeo".

1.2.2. ICAO Phonetics and Numbers

Modern radiotelephony and aviation uses spelling alphabets (the best-known of which is the **NATO Phonetic Alphabet**), in which the letters of the English alphabet are arbitrarily assigned words and names in an acrophonic manner[7] to avoid misunderstanding. Though often called "phonetic alphabets", spelling alphabets have no connection to phonetic transcription systems like the International Phonetic Alphabet (IPA).

The first internationally recognized alphabet was adopted by the International Telecommunication Union (ITU) in 1927. After World War II the International Air Transportation Association (IATA), recognizing the need for a single universal alphabet, presented a draft alphabet to the ICAO in 1947 which had sounds common to English, French, and Spanish. By 1952 the ICAO adopted a version which with minor changes was adopted by the Allied Forces then by North Atlantic Treaty Organization (NATO) and by the ITU in 1956.

The ICAO spelling alphabet was the product of extensive research to choose a set of words which would sound as different from each other as possible when spoken by people whose native language was not English over noisy and degraded communications channels (ICAO 1993).

The ICAO/NATO phonetic alphabet is a list of words used to identify letters in a message transmitted by radio or telephone. Spoken words from an approved list are substituted for letters. For example, the word **"Tower"** would be **Tango-Oscar-Whiskey-Echo-Romeo** when spelled in the phonetic alphabet. This practice helps to prevent confusion between similar sounding letters, such as "m" and "n", or “b” and “d”, and to clarify communications that may be garbled during transmission. For instance, the message "proceed to map grid DH98" could be transmitted as "proceed to map grid Delta-Hotel-Niner-Ait".

[7] Acrophony (Greek: *acro* uppermost, head + *phonos* sound) is the naming of letters of an alphabetic writing system so that a letter's name begins with the letter itself. For example, Greek letter names are acrophonic: the names of the letters α, β, γ, δ, are spelled with the respective letters: άλφα (*alfa*), βήτα (*bita*), γάμμα (*gamma*), δέλτα (*delta*). The Glagolitic and early Cyrillic alphabets, although not consisting of ideograms, also have letters named acrophonically. The letters representing /a, b, v, g, d, e/ are named *Az*, *Buky*, *Vedi*, *Glagol*, *Dobro*, *Est*. (Source: http://www.answers.com/topic/nato-phonetic-alphabet#International).

The ICAO phonetic alphabet is used when communications conditions are such that the information cannot be readily received without their use. Pilots should use the phonetic alphabet when identifying their aircraft during initial contact with air traffic control facilities. ATC facilities may also request pilots to use phonetic letter equivalents when aircraft with similar sounding identifications are receiving communications on the same frequency. Additionally, the phonetic equivalents are used for single letters and to spell out groups of letters or difficult words during adverse communications conditions. For example, a pilot may say he is in Visual Meteorological Conditions, or VMC. But if the air traffic controller has trouble hearing him, he may say he is Victor Mike Charlie.

A careful study of the words will reveal that they are words which if spoken aloud are not easily confused with other words. The words are distinctive in their sounds, so that they can be given over the radio to another person without confusion.

The ICAO Phonetic alphabet is becoming a world standard but is not compulsory. Within national boundaries and jurisdictions nations can use their own versions and spelling variations occur within different languages. In most versions of the alphabet, the non-English spellings Alfa and Juliett are found. *Alfa* is spelled with an ***f*** as it is in most European languages. The English and French spelling *alpha* would not be properly pronounced by speakers of some other languages whose native speakers may not know that ***ph*** should be pronounced as ***f*****.** *Juliett* is spelled with a ***tt*** for native French speakers because they may otherwise treat a single final *t* as silent.

In order to eliminate wide variations in pronunciation, the ICAO prescribes a kind of IPA pronunciation (but only for letters, not numbers). However, many versions freely available on the Internet labelled (IPA) are not officially sanctioned and may contain errors.

The IPA version prescribed by ICAO usually has a non-rhotic accent ('r' pronounced only before a vowel), as in /tʃɑːli/, /ʃɑːli/, /noˈvembə/ and /ˈjunifɔːm/. The IPA from ICAO form of *Golf* implies it is pronounced /gʌlf/ which perhaps occurs in some English dialects, but not in either British RP or General American English. Furthermore, a nasal and velar phoneme **/ŋ/** in the IPA forms of *Tango* and *Yankee* is shown as a nasal and alveolar phoneme **/n/.**

Below is an example of **the ICAO phonetic alphabet** with the phonetic transcription (IPA from ICAO).[8] As you can see, in this version there are two columns with the pronunciation of the ICAO phonetic alphabet: the first one with Latin letters where stressed syllables are in **bold** and the second one with ICAO version of IPA phonetic transcription.

Letter	Code word	Pronunciation	IPA from ICAO
A	**Alfa**	(**AL**-FAH)	ælfɑ
B	**Bravo**	(**BRAH**-VOH)	brɑ'vo
C	**Charlie**	(**CHAR**-LEE or **SHAR**-LEE)	tʃɑːli or ʃɑːli
D	**Delta**	(**DELL**-TAH)	deltɑ
E	**Echo**	(**ECK**-OH)	eko
F	**Foxtrot**	(**FOKS**-TROT)	'fɔkstrɔt
G	**Golf**	(GOLF)	gʌlf
H	**Hotel**	(HOH-**TELL**)	ho'tel
I	**India**	(**IN**-DEE-AH)	'indiə
J	**Juliett**	(**JEW**-LEE- **ETT**)	'dʒuːli'et
K	**Kilo**	(**KEY**-LOH)	kiːlo
L	**Lima**	(**LEE**-MAH)	liːma
M	**Mike**	(MIKE)	maɪk
N	**November**	(NO-**VEM**-BER)	no'vembə
O	**Oscar**	(**OSS**-CAH)	'ɔskɑ
P	**Papa**	(PAH-**PAH**)	pə'pɑ
Q	**Quebec**	(KEH-**BECK**)	ke'bek
R	**Romeo**	(**ROW**-ME-OH)	'roːmio
S	**Sierra**	(SEE-**AIR**-RAH)	si'erɑ
T	**Tango**	(**TANG**-GO)	'tængo
U	**Uniform**	(**YOUNEE**-FORM or **OONI**-FORM)	'junifɔːm or 'unifɔrm
V	**Victor**	(**VIK**-TAH)	'vɪktɑ
W	**Whiskey**	(**WISS**-KEY)	'wiski
X	**X-ray**	(**ECKS-RAY)**	eks'rei
Y	**Yankee**	(**YANG**-KEY)	'jænki
Z	**Zulu**	(**ZOO**-LOO)	'zuːluː

ICAO phonetic alphabet

In the NATO/ICAO scheme it is not only the letters that are supposed to be pronounced in specified ways, but also the numbers. The two special

[8] Available at: http://www.answers.com/topic/nato-phonetic alphabet#International.

pronunciations are *fife* /faif/ for 'five' and *niner* /nainer/ for 'nine' since 'five' and 'nine' can sound the same over the radio. The numbers three /θri:/ and thousand /θaʊznd/ are pronounced as tree /tri:/ and tousand /'tauznd/, i.e. dental and fricative **/θ/** is replaced by alveolar and plosive **/t/. /θ/** is a 'marked sound', that is to say, it is relatively rare in the languages of the world. It seems to be a natural tendency for languages to tend to move away from marked sounds, changing them into less marked ones. **/θ/** is pronounced in different ways even by native speakers of English, and it is difficult to pronounce for many foreign speakers who often mistake it for **/s/** or even **/t/.**[9]

Digit	Pronunciation
0	ZERO
1	WUN
2	TOO
3	TREE
4	**FOW**-ER
5	FIFE
6	SIX
7	**SEV**EN
8	AIT
9	**NIN**ER
10	ONE-ZERO
25	TWO-FIFE
100	HUNDRED
140	ONE FOUR ZERO
500	FIVE HUNDRED
1200	ONE THOUSAND TWO HUNDRED
1230	ONE TWO THREE ZERO
4500	FOUR THOUSAND FIVE HUNDRED
10,000	ONE ZERO THOUSAND
12,000	ONE-TWO-THOUSAND
13,600	ONE THREE THOUSAND SIX HUNDRED
46,250	FOUR-SIX-TWO-FIFE-ZERO
118.1	ONE-ONE-EIGHT-DECIMAL-ONE

ICAO numbers

[9] One of the non-SBS/non-standard features of TH-fronting/stopping, where **/θ/** changes to **/f/**, in words like third /θɜːd/→/fɜːd/.This TH-fronting is also an extremely prevalent pronunciation in London (Čubrović 2009: 58).

When transmitting messages containing call signs, altimeter settings, flight levels, altitudes, wind velocity, heading, frequencies etc. each letter and digit should be pronounced clearly and accurately in order to avoid misunderstanding or confusion. All numbers should be transmitted by pronouncing each digit separately.

Numbers used in the transmission of altitude, cloud height, visibility and runway visual range (RVR) information, which contain whole hundreds and whole thousands, should be transmitted by pronouncing each digit in the number of hundreds or thousands followed by the word HUNDRED or THOUSAND as appropriate.

The pronunciation of numbers is indicated by respellings in order to avoid any confusion. However, the respelling of some numbers (e.g. *wun, too, ait)* is not clear, and we are not sure if they are pronounced as is usually the case: /wʌn/, /tuː/ and /eit/. The most confusing, in my opinion, is *fower* for 'four' and it could be pronounced as /fəʊə/ or /faʊə/. The purpose of this respelling may have been to avoid the non-rhotic /fɔː/. On the Audio CD produced by Oxford University Press 2008 (Aviation English for Pilots and Air Traffic Controllers – Sue Ellis & Terence Gerighty) the number four is pronounced /faʊə/ only when its pronunciation is introduced in isolation, but then speakers go on to pronounce four in the usual way /fɔː/ in examples of actual transmissions.

The ICAO, NATO, and FAA use the common English number words (with stress), but not always pronounced the same. Also, the pronunciation of the words in the alphabet as well as numbers may vary according to the language habits of the speakers.

My assumption is that the pronunciation of letters which is not precisely defined and the respellings of some numbers can cause confusion and misunderstanding. Phonetic transcription was originally devised to remove ambiguities that conventional spelling systems could not cope with. Thus, the IPA alphabet is a good solution, and pilots and controllers should be trained to read IPA. However, ICAO should ask a phonetician to advise on making respellings unambiguous.

2. NATURE OF ATC COMMUNICATIONS

The goal of ATC communications is to provide unambiguous, accurate, and current information and clearances to aircrews and controllers.

All aircraft flying in controlled airspace adhere to certain standard procedures. These operations have accompanying standard phraseology, thereby allowing all the parties in the air and on the ground at any given time to stay informed about the progress of the flight. ATC communications are voice only, that is controllers and pilots talk to each other at a distance, through radiotelephony communications. These communications are required to support coordination of aircraft movement in all phases of flight, to ensure aircraft separation, transmit advisories and clearances, and to provide aviation weather services.

> *Today's radiotelephony communications in aviation can only occur one-way and one at a time. This half duplex system has pros and cons. On the positive side the "party line," as it is often referred to, allows pilots to listen in and have awareness of other aircraft in the vicinity. On the negative side, if more than one person attempts to talk at the same time (referred to as "stepping on" someone's transmission), communications will be unintelligible with high pitched feedback interference. When a frequency is busy it may be difficult for pilots or controllers to communicate important information in a timely manner (Morrow & Rodvold 1998).*

It is of course important that radio equipment should be reliable and easy to use, and should be capable of conveying the spoken word clearly and without distortion over long distances. The process of pilot/controller communication is further complicated by environmental variables known as masking, clipping, and blocking/distortion.

Masking occurs when speech is difficult to understand because of unwanted noise. For example, the cockpit of an aircraft (particularly during take-off and climb phases) can be quite noisy.

Clipping occurs when a speaker does not use a microphone properly. A pilot may inadvertently begin to speak before keying a microphone, or, unkey the microphone before finishing his or her transmission. This can lead to broken communication, clutter, and frustration for others using the frequency.

Blocking is a very common problem in ATC communications. If two pilots are trying to transmit at the same time, the transmission will be blocked and everyone listening on the frequency will hear an ever familiar "screeching" or irritating "whistle". A "stuck" microphone can literally prevent everyone from talking or listening on the entire frequency.

The Air Traffic Controller must communicate with skill and precision. Optimum use of aeronautical radio communication facilities depends on the good techniques of the controller. It is a good procedure to listen briefly on the frequency to be used before transmitting to ensure that he/she will not interrupt or cause harmful interference to stations already in communications.

ICAO guidelines and techniques for radio transmission highlight the following objectives:

- ✈ Transmissions shall be conducted concisely in a normal conversational tone;
- ✈ Full use shall be made of standard phraseologies, whenever prescribed in ICAO documents and procedures; and,
- ✈ Speech-transmitting techniques shall be such that the highest possible intelligibility is incorporated in each transmission.

To reach these objectives, pilots and controllers should:

- ✈ Enunciate each word clearly and distinctly;
- ✈ Speak at a moderate rate, neither too fast nor too slow. Maintain an even rate of speech (not exceeding – typically – 100 words per minute);
- ✈ Make a slight pause preceding and following numerals, this makes them easier to understand;
- ✈ Maintain the speaking volume at a constant level; High-pitched voices transmit better than low-pitched voices.
- ✈ Avoid hesitation sounds such as er or um;
- ✈ Be familiar with the microphone operating techniques (particularly in maintaining a constant distance from the microphone); and,
- ✈ Suspend speech temporarily if it becomes necessary to turn the head away from the microphone.

When speaking over a radio system, the speaker should be familiar with the equipment used. It is extremely important to be clear and loud when speaking over a radio system and know how close to be to the microphone to be heard and understood best by the listening party.

In ATC communications it is important to speak at a moderate rate and to maintain an even rate of speech. The ICAO recommends not exceeding 100 words per minute. Speech rate should be adjusted to allow clearances etc. to be written down if necessary. A recommendation is to speak "*staccato*," that is, to break the instruction up into its component words by inserting tiny pauses. It is particularly recommended to make a slight pause preceding and following numerals.

Good pronunciation means that people can understand what you say easily and that you do not create confusion. When talking to someone over the radio, it is important to enunciate, i.e. each word should be clear and distinct from the next one. Inadequate enunciation is the reason for unacknowledged instructions or requests for message repeats. In ATC communications poor enunciation by a sender can lead to misunderstanding. Some pilots and controllers may find certain words difficult to enunciate, particularly when they are busy, e.g.: 'Juliet Juliet Tango' becomes 'Jew Jew Tango'.

In fluent speech words within a speech unit are usually said without a break. The sound at the end of one word is linked to the sound at the beginning of the next so that there is a smooth connection between them. For example:

a serious◡accident, far◡ away, pure◡oxygen, who◡ is it?, can you see it?
/r/ **/w/** **/j/**

Languages modify difficult and complicated sequences in connected speech so as to simplify the articulation process. Thus, flight *deck* becomes /flai(t)dek/ or *load sheet* becomes /ləʊ(d)ʃiːt/.

English tends to have distinguishable patterns according to which such modifications occur. In the multitude of phonemic processes, some which can affect pilot/controller communication will be mentioned here. Assimilation, coalescence, gradation, liaison (linking processes) and elision are phonemic variations which are more likely to happen in more rapid colloquial speech.

○ **assimilation:**	ten miles of course	/'ten 'maɪls/ →/'tem 'maɪls/ /əv 'kɔːs/ →/əf 'kɔːs/
○ **coalescence:**	I lost you actual	/aɪ 'lɔstjʊ/ → /aɪ 'lɔstʃʊ/ /'æktjʊəl/ → /'æktʃʊəl/
○ **gradation:**	have must	/hæv/ → /hv, əv, v/ /mʌst/ → /məst, məs, mst, ms/
○ **elision:**	collision all right	/kə'lɪʒn/ → /'klɪʒn/ /ɔː(l)'raɪt/

Apart from the fact that phonemic variations can cause misunderstandings in pilot/controller communications, the stress, the intonation, the speed of speaking and the placement and duration of pauses may affect the understanding of any communication, whether in abbreviated or plain language.

In standard RT phraseology there are a lot of abbreviations and acronyms. ICAO abbreviations are converted into the unabbreviated words or phrases (except for those which, in accordance with ICAO, need not be spelled out, e.g. ATC, ILS, QFE, QNH, RVR, etc.). In standard English two, three and four-letter abbreviations said as individual letters often have main stress on the last letter and secondary stress on the first (the ˌU'K, the ˌBB'C etc.). However, in ATC communications each letter should be stressed in order to avoid confusion.

Stress can often make the meaningful difference between two words. More than a hundred pairs of words with the same or very similar spelling, differ in the place of their accent: nouns or adjectives have accent on the first syllable, and verbs on the last one. For example: IN-crease, PER-mit, PRO-gress are nouns, while in-CREASE, per-MIT and pro-GRESS are verbs – the phonemes are the same but the stress distinguishes the meaning.[10]

Compared to many other languages, English has a high degree of differential stress, the application of which is determined by some fairly complex rules. It is a very difficult aspect of English for speakers of such languages as Spanish, French, Japanese or Serbian, where differential stress is much less marked.

[10] Moreover, in some cases a different distribution of accents is possible; for instance the noun *decrease* has in addition to the pronunciation above, the pronunciation /di:'kri:s/, while the corresponding verb can be pronounced also as /'di:kri:s/ (Hlebec 2007: 75).

Intonation is the ‘music’ of a sentence, the way the speaker makes his or her voice rise or fall or both, and is connected to the intended meaning or mood of the speaker. Pitch is important in English insofar as it combines stress to produce characteristic intonation patterns in order to make a statement, a question or an exclamation. Even an affirmative statement becomes a question if spoken with a rising intonation: e.g. *You did? , The aircraft is taking off?*

A simple, one-word exclamation – right! - can be understood as enthusiasm, resignation or sarcasm, depending on the intonation. Stress on a particular word can radically alter the meaning of a sentence:

1. I’m LIStening.	(What are you doing?)
2. I’M listening.	(Who is listening?)
3. I AM listening.	(Why aren’t you listening?)

When under stress or in complex situations, speech becomes more rapid and frequent and can make communications very difficult to understand. Under these stressful conditions, changes in voice pitch can cause “slips of the tongue” that can lead to misunderstandings and errors (Prinzo & Britton 1993).

Excessive pauses within a transmission can lead to what Monan called the ‘delayed dangling phrase’, which he defined as the add-on of an explanatory phrase or sentence to a transmission that sounds, tonally and in contents, to have been already terminated. On a congested frequency, he noted, such afterthoughts run the risk of covering, or being covered by, another transmission. Monan reported this example from the ASRS data base:

An air carrier pilot radioed: "[Call sign] is maintaining zero nine zero ... (pause) ... as assigned". The pilot then heard the approach controller transmit: "... turn to one eight zero degrees". The pilot responded, "Roger, [call sign], turning to one eight zero". Thirty seconds later, the approach controller radioed: "(Call sign) where are you going ! You were given zero nine zero. Turn immediately and climb ..." It was some time before the pilot comprehended what had happened. The 180-degree heading had been for another aircraft: "as assigned" had blocked the other aircraft's call sign.

3. LANGUAGE-BASED COMMUNICATION PROBLEMS

The complexity and flexibility of natural language are problematic, however, because of the confusions and misunderstandings that can readily arise as a result of such specifically linguistic phenomena as ambiguity, unclear reference, differences in intonation (or punctuation in written language), and presupposition, as well as more general peculiarities of human interactions face-to-face or over the radio. Even when pilots and controllers both speak English fluently, there are pitfalls in the nature of language and the ways that language is heard (Cushing 1995).

Grayson and Billings' taxonomy of pilot-ATC oral communication problems included ten categories, of which at least three were specifically linguistic (Categorization of Pilot-ATC Oral Communication Problems Grayson and Billings 1981):

- ✈ ambiguous phraseology: message composition, phraseology, or presentation could lead to a misinterpretation or misunderstanding by a recipient
- ✈ inaccurate (transposition): misunderstanding caused by the sequence of numerals within a message
- ✈ misinterpretable (phonetic similarity): similar-sounding names or numerics led to confusion in meaning or in the identity of the intended recipient

3.1. Ambiguous phraseology

In a study of 6527 reports submitted by pilots and controllers to ASRS, there were 529 reported incidents that the authors, Grayson and Billings, classified as representing "ambiguous phraseology". In general, ambiguity is the presence of two or more meanings in a word, phrase, sentence, or passage.

For example, sentence (1), a classic example in the linguistic literature, can mean either (2a) or (2b), depending on whether the phrase *flying planes* is

intended to mean planes themselves that are flying or the activity of making planes fly (Chomsky 1958).

(1) Flying planes can be dangerous.

(2a) Planes that are flying can be dangerous.

(2b) To fly planes can be dangerous.

However, apart from grammatical, the sentences also contain lexical ambiguities, in which different meanings emerge as a result of there being more than one meaning for an individual word. Sentence (1) can be uttered with its (2a) reading to quiet a rowdy woodworking class, if planes is intended to mean carpentry tools rather than aircraft, and it can be uttered with its (2b) reading to express a reluctance to travel, if ***flying*** is intended to mean - being a passenger rather than a pilot (Cushing 1994: 8).

Ambiguity is an ever-present source of potential air-ground misunderstandings. For example, pilots use the term (3) for both (4a) and (4b) (Callback no. 49, 1983).

(3) **PD**

(4a) Pilot's discretion

(4b) Profile descent

Sentence (5) is interpreted sometimes as meaning that "the pilot maintains the heading indicated when lined up on the extended centre line of the runway" and sometimes as meaning that "the pilot takes a heading after liftoff to keep the aircraft travelling on the extended line of the runway."

(5) Maintain runway heading.

In some situations this difference can lead to a conflict between aircraft during a crosswind situation after take-off (Callback no. 75, 1985).

At an airport at which Local Control and Ground Control were combined, a construction vehicle B1, called (6)

(6) At the localizer road to proceed to the ramp.

A controller, knowing that B1 had called but not sure what the request had been, replied (7) and then proceeded to talk to aircraft while waiting for a reply.

(7) B1 Ground, Go ahead.

B1 misinterpreted the phrase *go ahead* as referring to his driving, rather than his speaking, and was halfway down his normal route of travel before the controller realized what had happened (Callback no. 104, 1988).

The Tenerife and John Wayne accidents both involved ambiguities, the former in the preposition *at,* and the latter in the verb *hold*.

Looking more closely at the dialogue that took place in the Tenerife case, we can see that misunderstanding the ambiguous phrase *at take-off* in line 1706:09.61 as meaning *waiting at the take-off point,* rather than *already on the take-off roll,* which was what the pilot intended, prevented the Tower from telling the pilot to abort his take-off. This misunderstanding resulted, in turn, from a prior confusion as to exactly what the clearance *you are cleared to the Papa beacon, climb to and maintain flight level nine zero, right turn after take-off* in line 1705:53.41 had been, because telling the pilot what to do *after take-off* does not necessarily constitute giving the pilot permission *to take off.*

The KLM pilot interprets the clearance as permission to fly to Papa Beacon, but the Tower appears to have intended it as permission to fly to that beacon only after having received further clearance to leave the ground. The use of alternative unambiguous phrases for the clearance and the take-off announcement would have enabled the controller to advise some action that might have averted the collision or prevented the take-off roll in the first place.[11]

The KLM pilot's otherwise perplexing use of the nonstandard phrase "at take-off", rather than a clearer phrase such as "taking-off", can be explained as a subtle form of what linguists refer to as "code switching". Careful studies of bilingual and multilingual speakers have shown that they habitually switch back and forth from one of their languages to another in the course of a conversation, not because of laziness or lack of attention, but because of inherent social and cognitive features of how language works, that are still poorly understood (Cushing 1995).

In the KLM pilot's case, the form of a verb that is expressed in English by the suffix "-ing" happens to be expressed in Dutch by the equivalent of "at" plus the infinitive, i.e. in Dutch syntax “at take-off” would be the same thing as “taking off”. Most native speakers of English would not know this distinction. It is understandable that the Spanish-speaking controller, proficient in English but not in Dutch, was equally unaware of the meaning of the Dutch KLM pilot. He interpreted the "at" in a literal way, indicating a place, the take-off point.

[11] Spanish Ministry of Transport and Communication, “Spaniards Analyze Tenerife Accident,” trans. U.S. National Transportation Safety Board (see Appendix 1: Tenerife Case)

Cushing (1994) provides the communications transcript of the 1981 John Wayne Orange County Boeing 737 crash where the controller and pilots used the word ‘hold’ to mean ‘stop’ (its aviation meaning) and ‘to continue’ (as in ‘hold your course’ in idiomatic conversational English). The resulting confusion led to 34 injuries, four of them classified as serious. The Flight 336 aircraft was destroyed by impact and post-impact fire when it landed with its gear retracted.[12]

While all accidents are tragic occurrences, some benefit is derived through standardization and reform. Standard words and phrases became regulation.

For example: 'Okay' is non-standard and now replaced by 'Roger'. According to the Pilot/Controller glossary of the Airman's Information Manual (AIM), "roger" means "I have received all of your last transmission", it should not be used by pilots or controllers to answer a question that requires a "yes" or "no" response. 'Take-off' is a non-standard word and is now replaced by 'departure'. Take-off is only used in the actual take-off roll. While waiting, 'departure' is used. ‘Go ahead’ is not used for any other purpose except for: Proceed with your message.

A familiar example of ambiguity in communication is the instruction *“take-off power”* issued by the pilot to initiate a missed approach procedure. In several cases this phrase has been interpreted by the first officer as an instruction to reduce (take off) power. Such misunderstandings have led to the replacement of this phrase by the potentially less ambiguous *“go-around power.”*

It is also recommended to avoid the use of a word in an instruction which could be misinterpreted as a digit (e.g. the word “to” could be confused with the digit “2”, or the word “for” with the digit “4”).

The next example depicts the problem with the similar sounding of the number ***two*** and preposition ***to*** (Callback no. 126, 1989):

(8)

1. Controller clears the aircraft to descend “two four zero zero.”
2. Pilot reads clearance back as “OK. Four zero zero.
3. Aircraft descends to 400 feet rather than the appropriate altitude of 2,400 feet.

   Controller: *2,400* ⇒Pilot: [*To*] *400*

[12] See Appendix 2: John Wayne Orange County case

3.2. Homophony

Homophony is another linguistic phenomenon which can lead to confusion in pilot/controller communications. **Homophones** are words that sound the same but are spelt differently. For example: *plane* and *plain, knot* and *not, there* and *their, wait* and *weight, brake* and *break, missed* and *mist, hear* and *here, right, write* and *rite, two, too* and *to, four* and *for* etc.

In an incident, a wide-body air carrier **A** landed on runway 22L and was advised to taxi inbound and hold short of 22R. Holding short of 22R, the captain asked (9), to which the controller responded (10).

(9) May we cross?

(10) Hold short.

A then crossed the departure runway with wide-body carrier **B** starting its departure roll. Consequently **A** cleared 22R approximately thirty seconds before **B** reached the intersection, with no evasive action taken by either aircraft.

When asked why he had crossed the runway, the **A** captain explained that he had heard (10) as (11) (Callback no. 22, 1981).

(11) Oh sure.

Synonyms are words or phrases that sound different and are spelt differently but have the same meaning. There are about fifty instances where the Federal Aviation Administration (FAA) and ICAO use different words for the same meaning. Some common aviation synonyms are listed below.

ICAO	FAA
APRON	RAMP
BACK TRACK	TAXI BACK
CONFIRM	VERIFY
CRUISING LEVEL	CRUISING ALTITUDE
DECIMAL	POINT
LINE UP AND WAIT	TAXI INTO POSITION AND HOLD
RADAR IDENTIFICATION LOST	RADAR CONTACT LOST

In aviation phraseology aviation specific vocabulary is reduced to one single meaning in order to avoid misunderstandings because of homonymy, which is potential for misunderstanding also among native English speakers, e.g.:

elevator (AmE) = lift (BrE) and

elevator = a movable control surface (in the aeronautical context)

Some words in aviation phraseology have more than one meaning, which can cause confusion. For example:

CONTACT APPROACH	type of approach to an airport	command to radio the controller who handles approaches
FLIGHT DECK	cockpit of an airplane	top of an aircraft carrier
ROLL	pivot in the air about longitudinal axis	move on wheels
SLOT	time interval for a takeoff	a part of forward edge of some wings
STAND BY	wait	standing (by ...)
TAXI	air taxi, hover taxi	when aircraft moves on its wheels
ZULU	name of letter Z	time at Greenwich meridian

I would like to point here to some words with aviation specific meaning which often cause confusion when translated into the Serbian language:

HEADING – The direction in which the longitudinal axis of an aircraft is pointed, usually expressed in degrees from North (true, magnetic, compass or grid).

COURSE – The intended direction of flight in the horizontal plane measured in degrees from north; or the direction of a line drawn on a chart representing the intended airplane path, expressed as the angle measured from a specific reference datum clockwise from 0° through 360° to the line.

TRACK – The projection on the earth's surface of the path of an aircraft, the direction of which path at any point is usually expressed in degrees from North (True, Magnetic or Grid).

BEARING – the angle between a direction and a reference direction as determined at the place of the observer. The reference direction is generally the North.

Heading is ‘kurs aviona’ in the Serbian language. The translation of the word **course** into Serbian is not ‘kurs’, but: putni ugao (tj. ugao izmedju pravca severa i zadate linije puta). **Track** is ‘linija puta’, and **bearing** is ‘smer’ (Čistogradov 1997).

3.3. Misunderstanding of words and numbers

The next examples depict the confusion caused by the similar sound of numbers or several number combinations: e.g. five and nine (5 and 9), seven and seventeen (7 and 17), five and fifteen (5 and 15), one zero thousand and one one thousand (10.000 and 11.000), flight level two zero zero and flight level two two zero (FL200 and FL220).

An international carrier inbound to the United States was handed off to a new Center after the captain read back the clearance (12a) and the first officer set the altitude selector to 20,000; to the initial contact from the flight (12b) the Center responded (12c).

(12a) Cleared to descend to two zero zero, cross two zero miles south of ZXY at two two zero.

(12b) Leaving two two zero for two zero zero.

(12c) Were you cleared to two zero zero?

The Center claimed later that the clearance had been only to 220, but the crew understood otherwise. They pointed out that the word *maintain* had not been used and that at the time of the query a new clearance could have been issued to maintain 220 (Callback no. 47, May 1983).

Aircraft call signs are particularly apt to be confused with one another. Call sign confusion can arise because of visual or phonetic confusion associated with the sequencing of letter and number groups in a call sign. Aircraft identification on radar screens and controllers' strips often use ICAO 3-letter groups plus a flight identifier number. Controllers can experience both visual and phonetic confusion with ICAO 3-letter groups and flight numbers relating to different airlines. For example, identical final letters (ABC&HBC), parallel letters and numbers (ABC&ADC; 1458 and 1478), block letters and figures (ABC&ABD; 14 and 142) and anagrams (DEC&DCE; 1542 and 1425).

Misunderstanding can derive from the overlapping number ranges that are shared by multiple aviation parameters. For example, 240 can be a flight level, a heading, an air speed or the airline's flight number.

The UK CAA has adopted certain non-standard phraseology designed to reduce the chance of mishearing or misunderstanding RT communications. This

phraseology is not in accordance with ICAO standards but is based on careful study of the breakdown of pilot/controller communications. The following paragraphs taken from the UK Manual of Radiotelephony3 summarize the main differences.

(a) The word ‘to’ is to be omitted from messages relating to FLIGHT LEVELS.

(b) All messages relating to an aircraft’s climb or descent to a HEIGHT or ALTITUDE employ the word ‘to’ followed immediately by the word HEIGHT or ALTITUDE.

(c) When transmitting messages containing flight levels each digit shall be transmitted separately. However, in an endeavour to reduce ‘level busts’[13] caused by the confusion between some levels (100/110, 200/220 etc.), levels which are whole hundreds e.g. FL 100, 200, 300 shall be spoken as “Flight level (number) HUNDRED”. The word hundred must not be used for headings.

3.4. Problems of reference

Sometimes ambiguity arises because of uncertain reference, in which there is a degree of indeterminacy as to just who or what is meant by a pronoun or pronounlike expression. For example:

She told the pilot her flight would be late.
The steward was ordered to stop smoking.

Words with uncertain reference, such as the pronouns **him** or **it**, or indefinite nouns such as **things**, can cause considerable confusion in aviation communications.

For example, in an accident that occurred at the Florida Everglades on 29 December 1972, the pilot and crew of an L-1011 had been pre-occupied with a nose-gear problem that they had informed several controllers about it during their trip. When the Miami International Airport approach controller noticed on radar that their altitude was decreasing, he radioed, "How are things coming along up there?" and the flight crew responded "OK".

[13] Any deviation from an assigned level in excess of 300 feet.

The crew was referring to the nose-gear problem, which, as it happens, they had just managed to fix, entirely unaware that there was any problem with altitude. But the controller interpreted OK as referring to the altitude problem, because that is what he had had in mind when he radioed the question. The aircraft subsequently crashed into the Everglades, resulting in 101 deaths (Cushing 1994).[14]

3.5. A conditional statement

Failure to make a clear distinction between a conditional statement and an instruction can put one or more aircraft in peril (Cushing 1994).

A captain reports having been told twenty miles from his destination "to intercept the localizer and descend to 4,000."Five miles outside the outer marker, level at 4,000 feet, he was told by the Centre, "the other aircraft on the approach in front of you has landed; you are number one for the approach, "which both the captain and the first officer interpreted as meaning "cleared for the approach". They thus left 4,000 on the glide slope and, two miles outside the marker, at 3,600 feet, they asked the Centre for permission to switch to the Tower, to which the centre replied, "You were only cleared to 4,000."Another aircraft was departing. The captain explains that even though "the magic words, 'Cleared for the approach' "were never heard (or said), "[we] were under the assumption we were cleared because we were told we were 'number one for the approach' and not told to hold or expect any delay."

The expectation of an instruction can prime a pilot to mistake a different communication for the anticipated instruction. In their study of more than 6000 ASRS reports, Grayson observed that "many instances of misunderstanding can be attributed to the expectation factor, that is, the recipient (or listener) perceives that he heard what he expected to hear in the message transmitted. Pilots and controllers alike tend to hear what they expect to hear.

This was demonstrated in May 1995 at Heathrow Airport, London, when a Lufthansa Airbus A300 took off without ATC clearance. It was the sixth such incident at a major UK airport since 1990.

[14] See Appendix 3: Florida Everglades Case

Investigators said that having lined up, the crew expected that their next instruction would be to take-off. In a fast-moving queue for take-off, the crew were further primed when they had lined up by seeing the aircraft ahead of them take off.

This type of misinterpretation can occur whether it is based on expectation, making assumptions, or the fact that we can interpret the meaning of a message to fits our frame of reference, not necessarily what the sender had intended the message to mean.

The ASRS database is fraught with examples of how meaning can be misinterpreted within the cockpit, between the cockpit and ATC, between the cockpit and the cabin, and essentially throughout the aviation environment.

It is probably impossible to eliminate the risk of ineffective communication leading to incidents and accidents. However, it is possible to minimize such risk by creating an awareness of the importance of effective communication, and this can be achieved only by incorporating effective communication behaviours into all aspects of the aviation safety environment.

CONCLUSION

This paper offers a detailed description and linguistic analysis of Aviation English (or Airspeak) and explains how Standard English has been modified to improve ATC flight communications. The goal of these grammatical, morpho-syntactic and semantic simplifications is to avoid confusion and misunderstandings. The conscious reduction of the phonemic inventory ensures better understanding and easier pronunciation.

My main interest was to emphasize the importance of clear speech and good pronunciation in pilot/controller communications. As can be seen, use of the radiotelephony alphabet clarifies conversation and prevents confusion in a difficult environment for communication. However, some aspects of ATC phraseology should be improved, and the paper offers some suggestions as to how the pronunciation of ICAO phonetic alphabet and numbers can be enhanced.

As part of their training, pilots and controllers should be provided with a deeper insight into the structures of language and the way that phrases and words can be misinterpreted. They must be aware of, and avoid, common types of linguistic misunderstandings that can readily arise as a result of such specifically linguistic phenomena as ambiguity, homophony, unclear reference, false assumptions, etc.

And as a final point I must emphasize that ATC phraseology should be taught to those who have a relatively advanced knowledge of English. Only then would they have the ability to avoid ambiguity or the ability to clarify and resolve ambiguous situations.

Appendix 1: Tenerife Case[15]

Los Rodeos airport, Tenerife, Canary Islands, 27 March 1977

17.05:44.6 KLM 4805: (First officer to the control tower) – The KLM ... four eight zero five is now ready for take-off ... uh and we're waiting for our ATC clearance (1705:50.77).

17.05:53.41 (Tenerife control tower) – KLM eight seven zero five you are cleared to the Papa Beacon, climb to and maintain flight level nine zero, right turn after take-off, proceed with heading zero four zero until intercepting the three two five radial from Las Palmas VOR (1706:08.09).

17.06:09.61 KLM 4805 (first officer) – Ah – roger, sir, we're cleared to the Papa Beacon, flight level nine zero, right turn out zero four zero until intercepting the three two five and we're now at take-off (17.06: 17.79). The 747 obtained clearance, but was not allowed to take off as yet. However, its captain, in a hurry, started advancing the throttle, having forgotten that another aircraft was still taxiing down the runway. The stressful situation was probably to blame. The controller was struck by a sudden doubt. He reminded the KLM captain that he had not been cleared for take-off.

17.06:20 (Tenerife control tower): OK ... Stand by for take-off, I will call you.

(1706:21.79) [Note: A squeal starts at 17.06:19.39 and ends at 17.06:22.06.]

17.06:23.6 (PanAm first officer): And we're still taxiing down the runway, the Clipper one seven three six. The last two messages were radioed simultaneously and were therefore heard as a long four-second high-pitched sound. The KLM 747 speed increased. Some 1,500 meters further on, the PanAm 747 was still taxiing down the runway.

17.06:25 (Tenerife control tower to the PanAm 747) - Roger alpha one seven three six report when runway clear.

17:06 :29 (PanAm first officer) - OK, we'll report when we're clear. (17:06:30.69)

17 :06 :30 (Tenerife control tower) - Thank you.

17 :06 :50: COLLISION: KLM on take-off run collides with PAA on ground.

[15] Tenerife Collision, more at: http://aviation-safety.net/specials/tenerife.

Appendix 2: John Wayne Orange County Airport Case[16]

John Wayne Orange County Airport, Santa Ana, California, February 17, 1981

0133:11 Tower: Air California three thirty six, you're cleared to land.

0133:33 Tower: Air California nine thirty one let's do it taxi into position and hold, be ready.

0133:37 AC 931: Nine thirty one's ready.

0133:52 Tower: Air Cal nine thirty one traffic clearing at the end, clear for take-off sir, Boeing seven thirty seven a mile and a half final.

0133:57 AC 931: In sight we're rolling.

0134:13 Tower: OK Air Cal three thirty six, go around three thirty six, go around.

(0134:16 AC 336 captain: Can we hold, ask him if we can – hold.)

0134:18 Tower: Air Cal nine thirty one if you can just go ahead and hold.

0134:21 AC 336: Can we land Tower?

0134:22 Tower: Behind you Air Cal nine thirty one just abort.

0134:25 Tower: Air Cal three thirty six, please go around sir traffic is going to abort on the departure.

(0134:27 AC 336 Captain: Gear up.

0134:36: IMPACT: Aircraft lands with gear retracted.

[16] National Transportation Safety Board, "Aircraft Accident Report: Air California Flight 336 Boeing 737-293, N468AC, John Wayne Orange County Airport Santa Ana, California, February 17, 1981," report NTSB-AAR-81-12, 1981.

Appendix 3: Miami International Airport Case[17]

Miami International Airport, 29 December 1972

23.34:05: Ah, Tower this is Eastern, ah four zero one, it looks we're gonna have to circle, we don't have a light on our nose gear yet.

23.34: 14 Tower: Eastern four oh one heavy, roger, pull up, climb straight ahead to two thousand, go back to approach control, one twenty eight six.

23.34: 21 EAL 401: Okay, going up to two thousand, one twenty eight six.

23.35:09 EAL 401: All right, ah, approach control, Eastern four zero one, we're right over the airport here and climbing to two thousand feet, in fact, we've just reached two thousand feet and we've got to get a green light on our nose gear.

23.36:27 MIA Approach Control: Eastern four oh one, turn left heading three zero zero.

23.38:46 EAL 401: Eastern four oh one'll go ah, out west just a little further if we can here and, ah, see if we can get this light to come on here.

23.41 Second officer within cockpit: I can't see it, it's pitch dark and I throw the little light, I get, ah, nothing.

23.41:40 MIA Approach Control: Eastern, ah, four oh one how are things comin' along out there?

23.41: EAL 401: OK, we'd like to turn around and come, come back in.

23.41: 47 MIA Approach Control: Eastern four oh one turn left heading one eight zero.

23.42: 12: IMPACT: Aircraft crashes into the Everglades.

[17] National Transportation Safety Board, "Aircraft Accident Report: Eastern Airlines, Inc., L-1011, N310EA, Miami, Florida, December 29, 1972,"report NTSB-AAR-73-14, 1973.

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