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Air-Ground Communication Safety Study
Causes and Recommendations

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Edition Number	**:**	**1.1**
Ref		**DAP/SAF 2006-09**
Edition Date	**:**	**16/01/2006**
Status	**:**	**Released Issue**
Intended for	**:**	**General Public**

DOCUMENT CHARACTERISTICS

TITLE		
Air-Ground Communication Safety: Causes and Recommendations		
	EATMP Infocentre Reference:	
Document Identifier	**Edition Number:**	1.1
Safety Occurrence Package	**Edition Date:**	16/01/2006

Abstract

This report presents the analysis of 535 reported occurrences related to communication problems in Europe. The occurrence data used in the current study have been collected from European airlines and Air Navigation Service Providers. A survey of European airline pilots and air traffic controllers was organised in this study to identify lessons learnt and recommendations in the area of communication safety. The report provides a summary of the recommendations made by pilots and air traffic controllers in the survey questionnaire with respect to the following types of communication problems: similar call-signs, loss of communication, frequency change, non-standard phraseology, blocked transmission and radio interference.

This report is the result of a study conducted by the National Aerospace Laboratory NLR under a contract awarded by EUROCONTROL.

Keywords

Communication	PLOC	Non-standard phraseology	Blocked transmission
Readback	Similar call-sign	RT	
Hearback	Frequency change	Radio interference	

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STATUS, AUDIENCE AND ACCESSIBILITY					
Status		**Intended for**		**Accessible via**	
Working Draft	☐	General Public	☑	Intranet	☐
Draft	☐	EATMP Stakeholders	☐	Extranet	☐
Proposed Issue	☐	Restricted Audience	☐	Internet (www.eurocontrol.int)	☑
Released Issue	☑	*Printed & electronic copies of the document can be obtained from the EATMP Infocentre (see page iii)*			

ELECTRONIC SOURCE		
Host System	Software	Size
Windows_NT	Microsoft Word 8.0b	1396 Kb

DOCUMENT APPROVAL

The following table identifies all management authorities who have successively approved the present issue of this document.

AUTHORITY	NAME AND SIGNATURE	DATE
Safety Improvement Coordinator	T. BLAJEV 	December 2005
SSAP Programme Manager	T. LICU 	January 2006
Head of Safety Enhancement Business Division	E. MERCKX 	January 2006

DOCUMENT CHANGE RECORD

The following table records the complete history of the successive editions of the present document.

EDITION NUMBER	EDITION DATE	REASON FOR CHANGE	PAGES AFFECTED
0.1	15/12/2004	Working Draft	All
0.2	09/06/2005	Working Issue	All
0.3	26/07/2005	Proposed issue	All
1.1	16/01/2006	Released issue	All

CONTENTS

Executive Summary

Within the EUROCONTROL Safety Improvement Sub-Group (SISG), Communication Safety has been identified as a subject for a Safety Improvement Initiative. The scope of the initiative has been restricted to the air-ground communication function. A previous study aiming at the initial evaluation of the risk associated with the air-ground communication was performed in 2004 and provided a synthesis of the issues related to air-ground communication safety. Based on the initial evaluation, SISG 14 and Safety Team 20 recommended further detailed analysis and elaboration of recommendations, addressing the high risk areas of air-ground communication safety. The National Aerospace Laboratory NLR was contracted by EUROCONTROL to conduct this study in support of SISG activities. The scope of the study was communication between pilots and air traffic controllers during all phases of flight within Europe.

A first step in reducing the incidence of communication problems is to understand why and how they happen. In the past, a number of studies have been conducted on the subject of pilot-controller communication errors. The majority of these studies were based on data obtained from incident reporting systems in the United States of America and the results of these studies might not necessarily apply in Europe. The present study therefore organised an occurrence reporting campaign addressing European airlines and Air Navigation Service Providers in order to collect a representative occurrence data sample on air-ground communication problems. Simultaneously, a survey of airline pilots and air traffic controllers in Europe was organised within the framework of the study to identify lessons learnt, best practice, and recommendations in the area of communication safety.

This report presents the analysis of 535 reported occurrences related to communication problems. Furthermore, a summary of the recommendations made by pilots and air traffic controllers in the survey is provided with respect to the following types of communication problems: similar call-signs, loss of communications, frequency change, non-standard phraseology, blocked transmission and radio interference. As a result of the analysis of the occurrences and the recommendations from the pilots and controllers participating in the survey, the current study presents conclusions and recommendations.

Chapter 1
Introduction

1.1 Background

Communication between air traffic controllers and pilots remains a vital part of air traffic control operations. Problems with it can result in hazardous situations. A first step in reducing the incidence of communication problems is to understand why and how they happen. In the past, a number of studies have been conducted on the subject of pilot-controller communication errors. The majority of these studies were based on data obtained from incident reporting systems in the United States of America and the results of these studies might not necessarily reflect the situation in Europe.

Within the EATM framework, EUROCONTROL SAF (Safety Enhancement Business Division) is supporting the enhancement of Air Traffic Management Safety in a Single Pan-European Sky. As part of its mission, SAF is initiating European-wide safety improvement initiatives based on risk-derived priorities, and involving the whole aviation community. The main working and consultation body managing the initiatives is the EUROCONTROL Safety Improvement Sub-Group (SISG). The SISG has identified Communication Safety as a subject for a Safety Improvement Initiative. The scope of the initiative has been restricted to the air-ground communication function.

In 2004 a study was conducted by the Dutch National Aerospace Laboratory NLR, to evaluate the risks associated with air-ground communications. The study analysed incidents related to communication between pilots and controllers, and the subsequent report [Ref. 1] provided a synthesis of the significant safety issues, hazardous scenarios, causal factors, and potential prevention strategies. Based on this initial evaluation, SISG 14 and Safety Team 20 recommended further detailed analysis and elaboration of recommendations, addressing the high risk areas of the air-ground communication identified in [Ref. 1]. NLR was contracted by EUROCONTROL to conduct this further study in support of the SISG activities.

1.2 The objective and scope of the current study

The overall objective of the current study is to perform a detailed analysis and elaboration of recommendations addressing the identified high-risk areas in air-ground communications [Ref. 1]. These areas include similar call-signs, loss of communications, frequency change, non-standard phraseology, blocked transmission and radio interference. The scope of the study is communication between pilots and controllers during all phases of flight within Europe.

1.3 Organisation of this report

This report presents the analysis and the results of the study on air-ground communication safety, focusing on causes and safety recommendations. Chapter 2 describes the occurrence reporting campaign that was held with European airlines and Air Navigation Service Providers (ANSP) in order to collect a representative occurrence data sample on air-ground communication problems. Chapter 2 also explains how a survey of European airline pilots and air traffic controllers was organised to identify lessons learnt and recommendations in the area of communication safety. Chapter 3 deals with the results of the analysis of the air-ground communication occurrence data obtained from the occurrence reporting campaign. Chapter 4 addresses the results of the analysis of the survey responses. Chapter 5 discusses the results and compares them to the previous NLR study [Ref. 1]. Finally, conclusions and recommendations are presented respectively in Chapters 6 and 7. Appendix A gives an overview of the literature study that was performed in the context of this study. Appendix B contains the Electronic Reporting Form that was used in the occurrence reporting campaign. Appendix C shows the web-based questionnaire used in the survey of air traffic controllers and pilots. Appendix D includes the EUROCONTROL invitation letter to participate in the occurrence reporting campaign, which was sent to airlines and ANSPs.

Chapter 2
Analysis approach

2.1 Introduction

A first step in reducing the incidence of communication problems is to understand why and how they happen. In the past, a number of studies have been conducted on the subject of pilot-controller communication errors. The majority of these studies were based on data obtained from incident reporting systems in the United States of America. Because the results of these studies might not reflect the situation in Europe, the present study organised an occurrence reporting campaign addressing European airlines and Air Navigation Service Providers (ANSP) in order to collect a representative occurrence data sample on air-ground communication problems reflecting the situation in Europe. At the same time, a survey of airline pilots and air traffic controllers in Europe was organised to identify lessons learnt and their (subjective) recommendations in the area of communication safety. The current study also conducted a literature review on air-ground communication safety issues, using the extensive library of NLR for this purpose. This chapter explains the taxonomy used throughout this study (2.2), the literature review (2.3), the occurrence reporting campaign (2.4) and the survey (2.5).

2.2 Taxonomy

The definitions used to code air-ground communication occurrences in the present study adopted the taxonomy used in the previous study [Ref. 1]. The following generic communication problems have been defined in the taxonomy:

- Readback/Hearback errors - *The pilot reads back the clearance incorrectly and the controller fails to correct the error. Also used when a pilot of the wrong aircraft reads back the instruction.*
- No pilot readback - *A lack of a pilot readback*. *The pilot does not indicate to the controller that he/she understands the clearance by repeating (reading back) the message.*
- Hearback Errors - *The controller fails to notice his or her own error in the pilot's correct readback or fails to correct critical erroneous information in a pilot's statement of intent.*
- Communication Equipment problem - *Problems caused by the improper functioning of communication equipment in the aircraft or on the ground.*
- Loss of communication - *Self explanatory.*
- Other - *Self explanatory.*

The following consequences are defined in the taxonomy:

- Altitude deviation - *A departure from, or failure to attain, an altitude assigned by ATC.*
- Runway transgression - *The erroneous or improper occupation of a runway or its immediate vicinity by an aircraft that poses a potential collision hazard to other aircraft using the runway, even if no other aircraft were actually present (definition taken from ASRS).*
- Wrong aircraft accepted clearance - *Self explanatory.*
- Prolonged loss of communication - *No response from subject aircraft when called by ATC or other aircraft. Typical duration of communication loss in terms of minutes or more.*
- Loss of separation - *Less than the prescribed separation between aircraft.*
- Heading or track deviation - *Failure to fly assigned heading/track*.
- Instruction issued to wrong aircraft - *Self explanatory.*
- Unknown - *Self explanatory.*
- None - *Self explanatory.*

A contributing factor is defined as an item, which was judged to be instrumental in the causal chain of events leading to the occurrence. Table 1 lists the factors used in the present taxonomy.

A sleeping VHF receiver problem is defined as *loss of communication type in which the VHF frequency becomes silent for a period of time.*

Table 1: Contributing factors.

Contributing factors	
Ambiguous phraseology	Sleeping VHF receivers
Blocked transmission	Partial readback
Content of message inaccurate/incomplete	Pilot accent/non-native
Controller accent/non-native	Pilot distraction
Controller distraction	Pilot expectation
Controller fatigue	Pilot fatigue
Controller high speech rate	Pilot high speech rate
Controller non-standard phraseology	Pilot non-standard phraseology
Controller workload	Pilot workload
Frequency change	Radio equipment malfunction - air
Frequency congestion	Radio equipment malfunction - ground
Garbled message	Radio interference
Issue of a string of instructions to different aircraft	Similar call-sign
Language problems	Stuck microphone
Long message	Untimely transmission

2.3 Literature study

Over the years a large number of studies have been conducted on air-ground communication problems to investigate the causes and to suggest improvements. In order to obtain an overview of available information on the problem and recommendations that could be used in the present study, a review of existing literature was performed. For this review the literature available within NLR was used. In Appendix A the summary of the literature study is presented, categorised by main type of communication problem: readback/hearback errors, no pilot readback, hearback errors, communication equipment problem, and loss of communication.

Main findings

In the past decades a lot of research has been performed on communication between controllers and pilots. It is clear that over the years the different studies found similar communication problems and causes of communication errors. One may conclude that despite the studies and recommendations that have been made in the past, controllers and pilots continue to make the same communication errors. This is not surprising because pilot-controller communication is still highly dependent on the human factor. Nevertheless, the 'system' is robust in a sense that millions of instructions are given per year, whereas the number of reported occurrences is relatively small. Many instances of miscommunication and communication problems are apparently caught and solved by the controllers and pilots, leaving them only with momentary confusion or annoyance. On the other hand, communication plays a vital role in aviation and a breakdown in communication can have serious safety consequences.

It is observed in the literature study that most communication problems have causal factor associated with human performance limitations. Factors often mentioned in the various studies are controller workload, frequency congestion, non-standard phraseology, readback/hearback errors, similar call-signs, message complexity, speech rate, language proficiency and accent.

Only a few studies address communication problems related to equipment failure. In fact, only a small portion of communication problems are the result of equipment problems. However, in recent years the problem of sleeping VHF receivers (PLOC type A) has received close attention. A software modification has been installed on certain types of radio in service with affected airlines that will monitor, and if necessary correct, the possibility that a VHF transmitter does not return to the receiving condition after a radio transmission by the crew.

2.4 The occurrence reporting campaign

2.4.1 The organisation of the occurrence reporting campaign

A reporting campaign was set-up in order to gather incident data related to air-ground communication occurrences in Europe, such as similar call-signs, sleeping VHF receivers, frequency change, non-standard phraseology, blocked transmission and radio interference (these were identified as high-risk areas by [Ref. 1]). European ANSPs and airlines were contacted and briefed on the initiative and were invited to participate in the confidential and de-identified reporting campaign[1] (the invitation letter to airlines and ANSPs is inserted in Appendix D). Twelve airlines participated in the reporting campaign together with ten ANSPs. The reporting campaign started 25 October 2004 and ran through to 31 March 2005.

2.4.2 The electronic occurrence reporting form

An electronic occurrence reporting form was created in Microsoft Excel, so that flight safety officers from airlines and ANSPs could submit air-ground communication occurrences to the study team in a standard format. Some airlines opted to provide data in a BASIS (British Airways Safety Information System) format, which were transferred later to the format of the reporting form. The electronic occurrence reporting form included several fields with multiple choice options and one open field for comments. Besides general fields, like flight phase, location, date and time of the occurrence, the reporters could fill out the particular type of communication problem at hand and the consequence(s). They could also assign contributing factors to the occurrence. The available multiple choices for the type of communication problem, the consequences and the contributing factors are presented in section 2.2 and Table 1. An example of the electronic reporting form is inserted in Appendix B.

[1] The project team had only access to the de-identified information, because the purpose of the project is to identify air-ground safety occurrences, the causal factors, consequences and safety recommendations, and not to apportion blame etc.

2.5 The survey of pilots and controllers

A survey of airline pilots and air traffic controllers was organised to identify lessons learnt and potential safety recommendations in the area of air-ground communication in Europe. The survey questionnaire was prepared and set-up so that participants could easily respond through the project website on the Internet. The questionnaire was in three parts. First of all, participants were asked to provide information on their career, e.g. their experience. Secondly, the survey addressed six types of communication problem: similar call-signs, sleeping VHF receivers, frequency change, non-standard phraseology, blocked transmission and radio interference. The participants were asked to provide their experience with each of these problems and suggest safety recommendations to avoid or mitigate the particular problem. Finally, participants were invited to submit any general comments they might have on air-ground communications safety. The questionnaire is at Appendix C.

Professional airline pilot and air traffic controller organisations such as the International Federation of Air Traffic Controllers' Associations (IFATCA) were asked for their participation in the survey. These organisations were involved in supporting the survey and spreading the news about the survey to their members.

Chapter 3
Results of the occurrence reporting campaign

3.1 Introduction

The occurrence reporting campaign was aimed at European airlines and Air Navigation Service Providers (ANSP) in order to provide data on air-ground communication problems in Europe. This campaign resulted in a data sample of air-ground communication occurrences, which were all classified as incidents[2]. This chapter presents the results of the analysis of these occurrences. In the next section the results of the data analysis with respect to the overall data sample of communication occurrences will be presented. Sections 3.3 through 3.9 will present the analysis of the following communication problems: loss of communication (3.3), readback/hearback error (3.4), communication equipment problem (3.5), no pilot readback (3.6) and hearback error (3.7). The analysis of the occurrences which have been reported in the category 'other communication problem' will be addressed in section 3.8. Finally, section 3.9 will present the analysis of the occurrences in which the communication problem was not reported by the airlines or ANSPs.

[2] Defined by ICAO as an occurrence, other than accident, associated with the operation of an aircraft, which affects or could affect the safety of operation.

3.2 Results of the overall data sample

3.2.1 General

The total data sample included 535 occurrences of communication problems between air traffic controllers and pilots. The occurrences took place in European airspace between March 2004 and April 2005. Most of the occurrences (62%) were reported by pilots. Air traffic controllers reported 37% of the occurrences. In a few cases it was not clear who had reported the occurrence (1%).

3.2.2 Generic communication problems

Figure 1 and Table 2 show that loss of communication is the most common type of communication problem reported in the data sample (i.e. in 26% of the occurrences). Both readback/hearback error and communication equipment problem account for about 10% of the reported occurrences. Hearback error and no pilot readback are infrequently reported.
Communication problems which did not fit into one of the five types of communication problems or which could not be classified due to a lack of information have been reported in the category 'other communication problem' in the occurrence reporting campaign. This category covers 36% of the reported occurrences. In 18% of the occurrences the type of communication problem was not reported by the airlines or ANSPs.

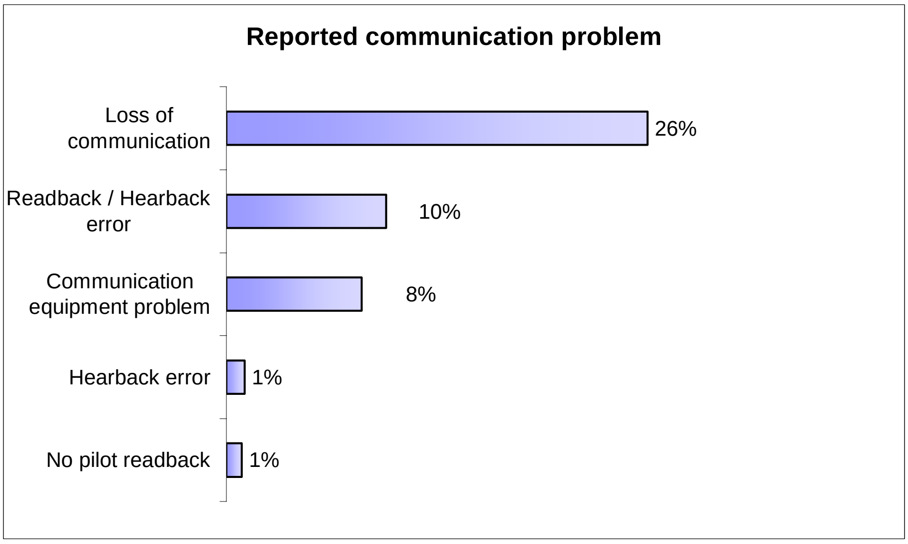

Figure 1: Distribution of the reported communication problems.

Table 2: Reported communication problems.

Generic communication problem	Occurrences	Percentage
Loss of communication	137	26%
Readback / Hearback error	52	10%
Communication equipment problem	44	8%
Hearback error	6	1%
No pilot readback	5	1%
Other communication problem	194	36%
Communication problem not reported	97	18%
Total number of occurrences	535	

The time of the day at which the reported occurrences took place is shown in Figure 2. The data set reveals that most of the reported occurrences took place in the morning (37%).

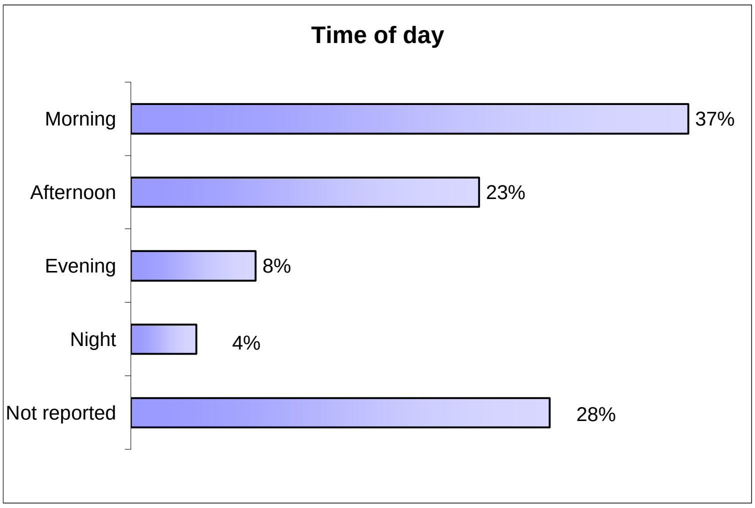

Figure 2: Distribution of the reported communication problems by time of day.

3.2.3 Consequences of communication problems

Figure 3 shows the distribution of the consequences of the reported communication problems. This study finds that a large portion of communication problems (36%[3]) have no safety consequence. About a quarter of the reported occurrences resulted in a prolonged loss of communication (PLOC). Note that more than one consequence could be assigned to a single occurrence. Table 3 shows that in 305 occurrences only a single consequence was reported and in 27 occurrences two consequences were reported. In one occurrence there were three consequences reported.

[3] Percentage of total number of reported occurrences.

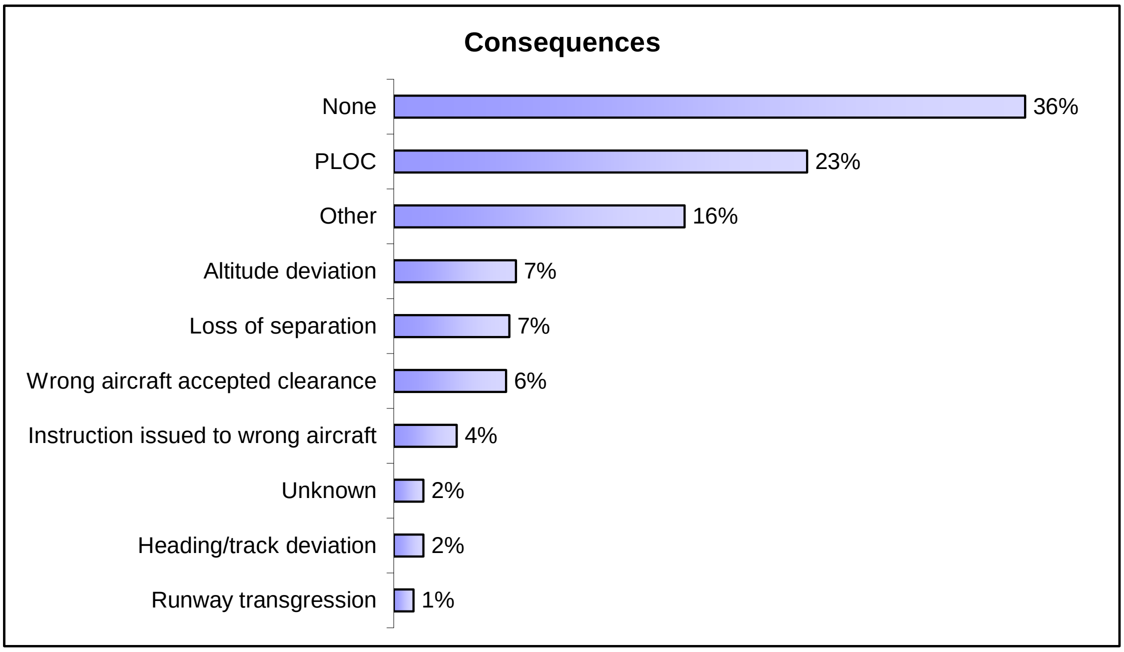

Figure 3: Distribution of the consequences of the reported communication problems.

Table 3: Number of consequences cited per occurrence.

Number of consequences	Occurrences	Percentage
Single consequence	305	57%
Two consequences	27	5%
Three consequences	1	0.2%
Consequence not reported or no consequence	202	38%
Total number of occurrences	535	

3.2.4 Flight phase distribution of communication problems

Figure 4 depicts the distribution of the communication problems by flight phase. The majority of the communication problems occurred in cruise flight. Communication problems close to the airport (i.e. during taxi, take-off, initial climb, approach and landing) account for 31% of the reported occurrences.

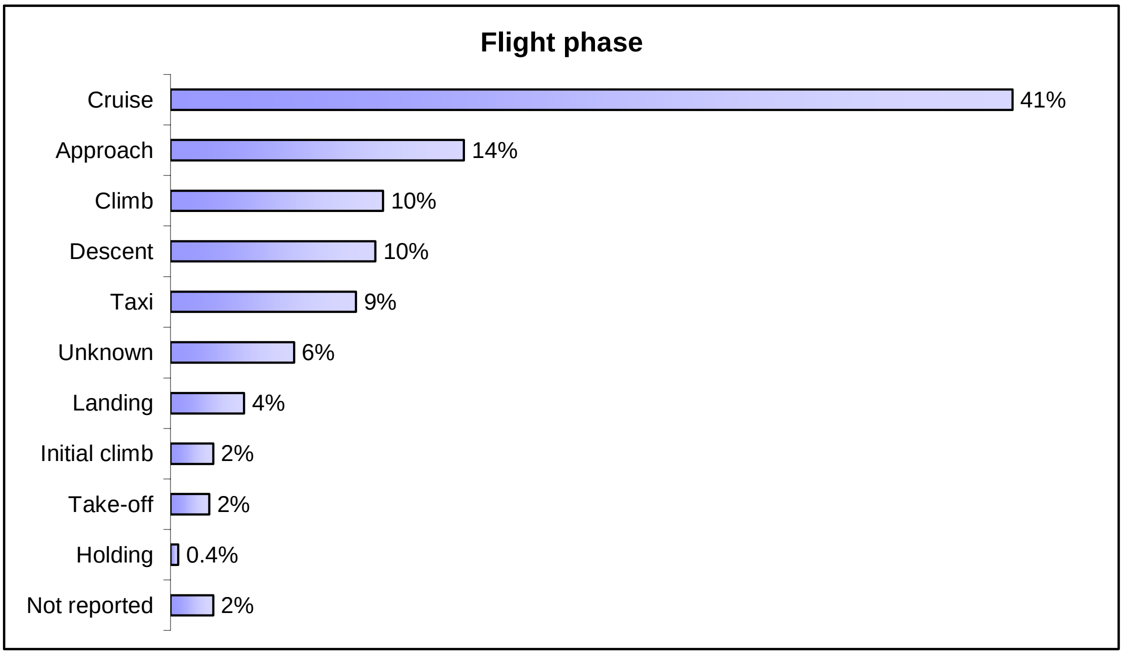

Figure 4: Distribution by flight phase of the reported communication problems.

3.2.5 Factors contributing to communication problems

The contributing factors reported in air-ground communication occurrences are shown in Figure 5. Note that more than one factor could be assigned to a single occurrence. The top five contributing factors are presented in Table 4. Similar call-sign was the most common contributing factor in the overall data sample of reported communication occurrences.

Table 4: Top five contributing factors in the reported communication problems.

Factor	Occurrences	Percentage
Similar call-sign	175	33%
Frequency change	64	12%
Radio equipment malfunction - air	43	8%
Radio interference	42	8%
Content of message inaccurate/incomplete	29	5%

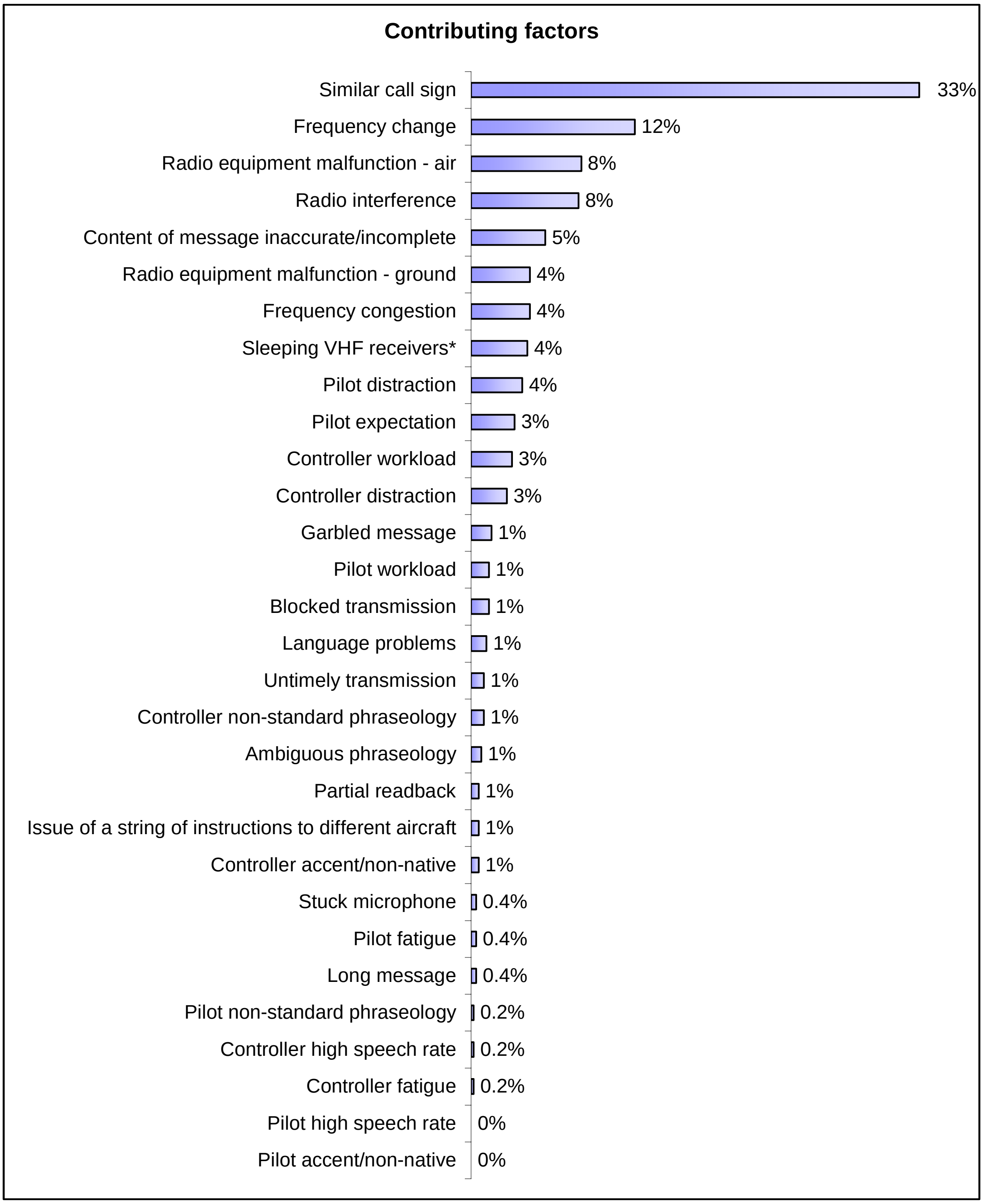

Figure 5: Frequency distribution of contributing factors in occurrence reports.

In 360 (66%) occurrences a single contributing factor was reported, and in 66 (12%) occurrences two contributing factors were assigned to a single occurrence. Three and four contributing factors were assigned to a single occurrence in 12 (2%) and 5 (1%) occurrences respectively, whereas in 92 (17%) occurrences no contributing factor was reported.

3.3 Results of the category 'loss of communication'

Loss of communication is a generic term for communication problems, but typically refers to situations in which the crew loses radio contact with ATC for some time for some reason. Occurrences involving loss of communication are significant from a safety and security perspective. 137 occurrences have been classified in the data sample as a loss of communication problem. Figure 6 shows the distribution by flight phase of these occurrences. This study finds that the majority of the occurrences involving a loss of communication occurred in the cruise phase (73%).

Figure 7 presents the contributing factors that were reported in the occurrences with a loss of communication. A frequency change is the most common factor in this type of communication problem (35%). A typical example of such an event is that the crew receives the frequency change too late and flies out of reach of the radio transmitter, selects the wrong frequency or mishears the new frequency. Sleeping VHF receiver and communication equipment failure are cited as factors in respectively 15% and 12% of the occurrences involving loss of communication.

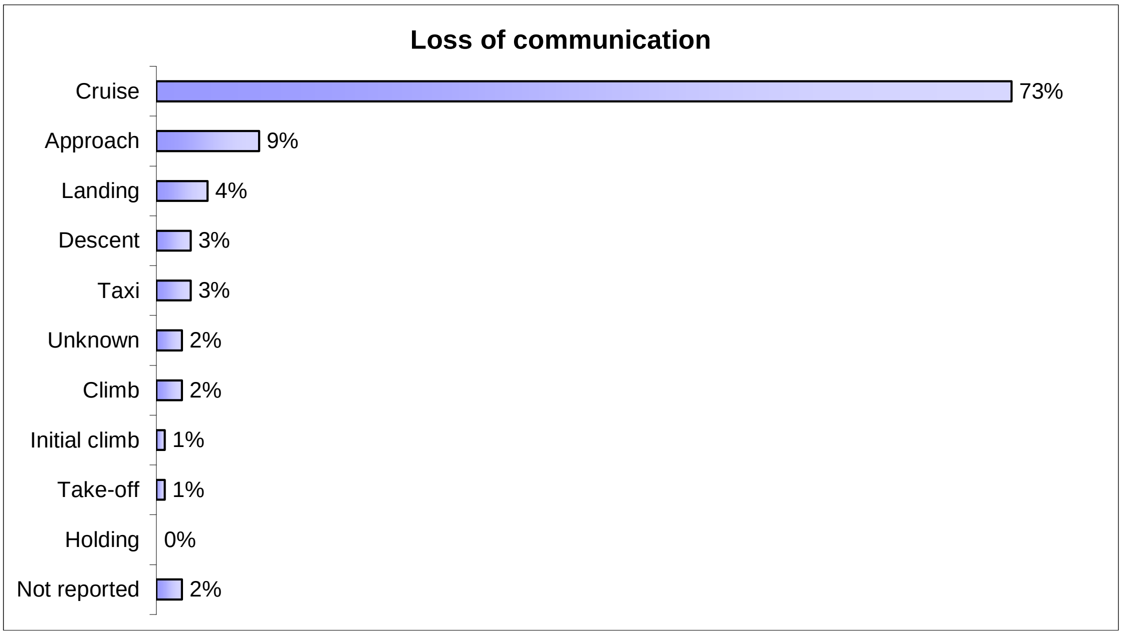

Figure 6: Distribution by flight phase of the occurrences involving loss of communication.

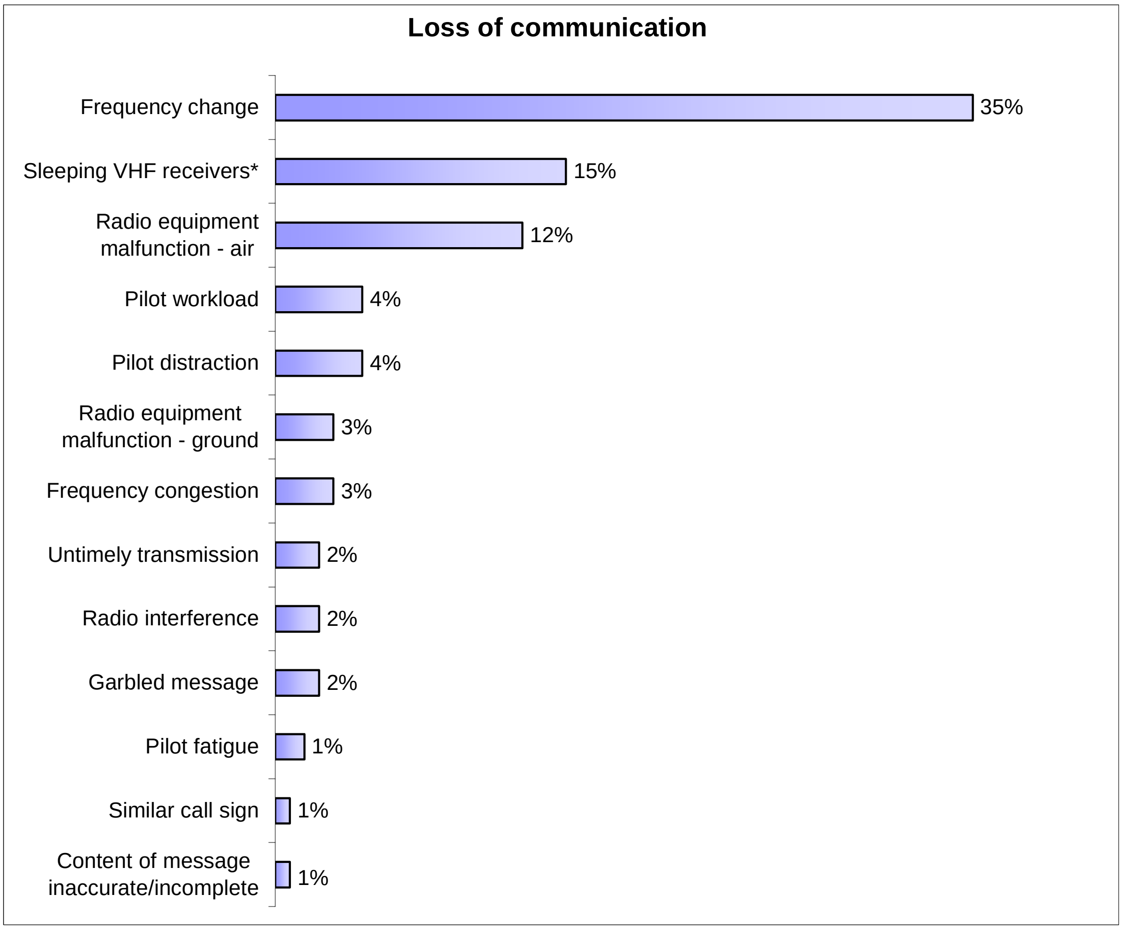

Figure 7: Contributing factors of the occurrences involving loss of communication.

A more detailed analysis was carried out on the main factors leading to the loss of communication occurrences, insofar as reporters had provided more details in the occurrence reports[4]. Examples of occurrence reports in this category of communication problems read:

- *"No. 1 comm. selector panel switched (on its own) to default frequencies several times during flight",*
- *"First officer's speaker off/headset on, captain speaker on/headset off, f/o leaves cockpit while captain inadvertently switches off his speaker", and*
- *"Aircraft not handed over, therefore out of comm. range".*

Many occurrences could not be analysed in more detail, because reporters had sometimes no clue of the reason for the communication loss, did not report any factors, or did not specify the factors or circumstances in the comment box.

[4] Besides selecting the factors from the list in Table 1, they could also provide explanations in the comment box of the reporting form.

The following set of factors related to human performance limitations, human-machine interface and communication equipment have been defined and examined by the study team in the 137 occurrences involving loss of communication.

Table 5: Factors assigned to loss of communication occurrences for detailed analysis.

Factor	Definition
Frequency misheard	*Self explanatory.*
Call-sign confusion	*Self explanatory.*
Wrong frequency assigned	*Self explanatory.*
Flight crew coordination failure	*Coordination and communication problems between flight crew members related to air-ground communication.*
Selector switched inadvertently	*Crew inadvertently selects switch on the radio/communication panel. Example: "Inadvertent rotation of VHF COM1 selecting knob while stowing charts from pedestal in preparation for approach".*
Flight crew missed ATC call	*Self explanatory.*
Frequency tuned incorrectly	*Crew selects wrong frequency, 'finger trouble'.*
Radio equipment malfunction	*Self explanatory.*
Speaker/radio volume low/off	*Crew inadvertently or on purpose switches off the speaker or turns down the volume but does not use headsets, or forgets to turn on the volume when not using headsets. Example: "crew forgets to restore VHF volume on speaker during failure checklist".*
ATC forgot to handover	*Air traffic controller forgets to hand the aircraft over with a new frequency before the aircraft leaves the sector and is out of reach.*

Frequency change problems in the category 'loss of communication'

Figure 7 shows that frequency change was cited as a factor in 48 of the 137 occurrences (35%) in the category 'loss of communication'. The occurrences in which the frequency change was a factor have been further specified in Table 6 by means of the factors in Table 5. A crew selecting the frequency incorrectly and the controller forgetting to hand over were the most common factors related to frequency change problems. In 14 of the 48 occurrences there was no further information available to determine the cause of the frequency change problem.

Table 6: Frequency of factors reported in occurrences involving loss of communication with contributing factor 'frequency change'.

Factor	Occurrences
Frequency tuned incorrectly	12
ATC forgot to handover	8
Flight crew missed ATC call	5
Radio equipment malfunction	2
Flight crew coordination failure	1
Selector switched inadvertently	1
Call-sign confusion	1

Airborne radio equipment malfunction and sleeping VHF receiver problems in the category 'loss of communication'

The occurrences in which 'radio equipment malfunction – air' and 'sleeping VHF receiver' were reported as a factor have been further analysed by means of the factors in Table 5. There was loss of contact in 7 of the 16 occurrences involving a radio equipment malfunction onboard the aircraft, while the cause of the malfunction was not specified. One of the 16 occurrences concerned a failure of the cockpit speaker. In two other occurrences the active frequency changed for undetermined reason (no pilot involvement). The factors in the six remaining occurrences were not specified.

There was no additional information available in the 18 occurrences. Most reports only mentioned that the crew lost contact or was unable to contact ATC for some time.

Detailed factors in the overall sample of occurrences of the category 'loss of communication'

Figure 8 present the distribution of the factors defined in Table 5 that were found in the 137 occurrences concerning loss of communication. The value of the additional information in the comments boxes was in general limited because of a lack of details. Figure 8 shows that one of the factors in loss of communication is the air traffic controller forgetting to hand over the aircraft whereby the crew does not receive a frequency change in time. Another factor is the flight crew tuning in the wrong frequency, which can be 'finger trouble', mishearing the frequency or selecting a wrong frequency.

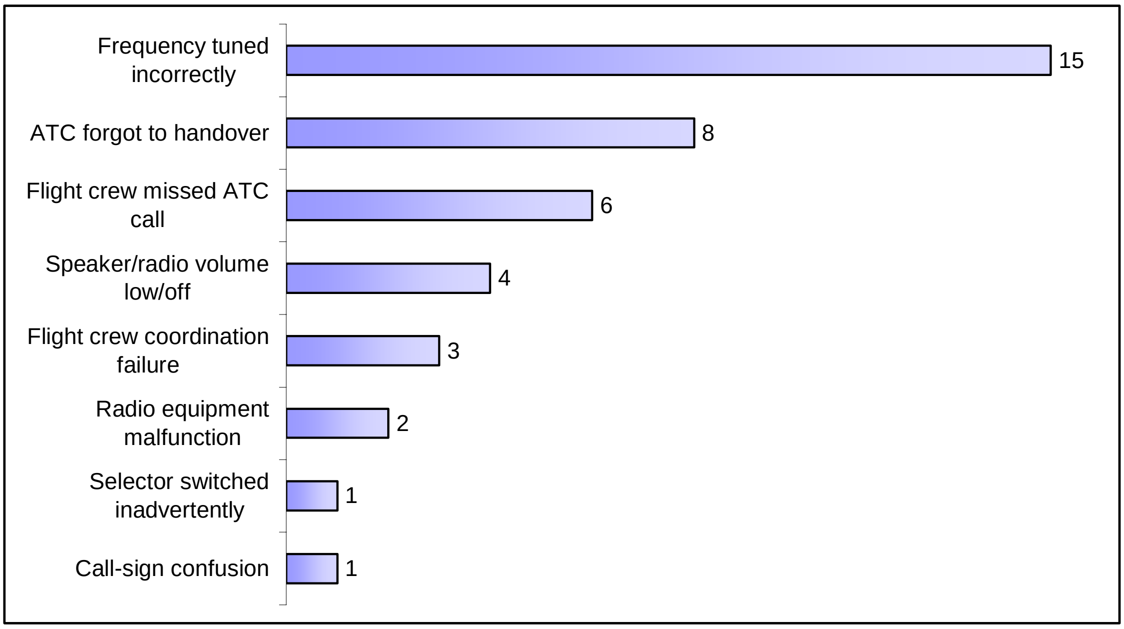

Figure 8: Distribution of the frequency of occurrence of human, human-machine interface and technical factors involved in the loss of communication occurrences in the data sample.

Figure 9 shows the consequences of the occurrences involving loss of communication. As could be expected, this type of communication problem results in a prolonged loss of communication in the majority of the occurrences (81%). Note that an occurrence can have more than one consequence.

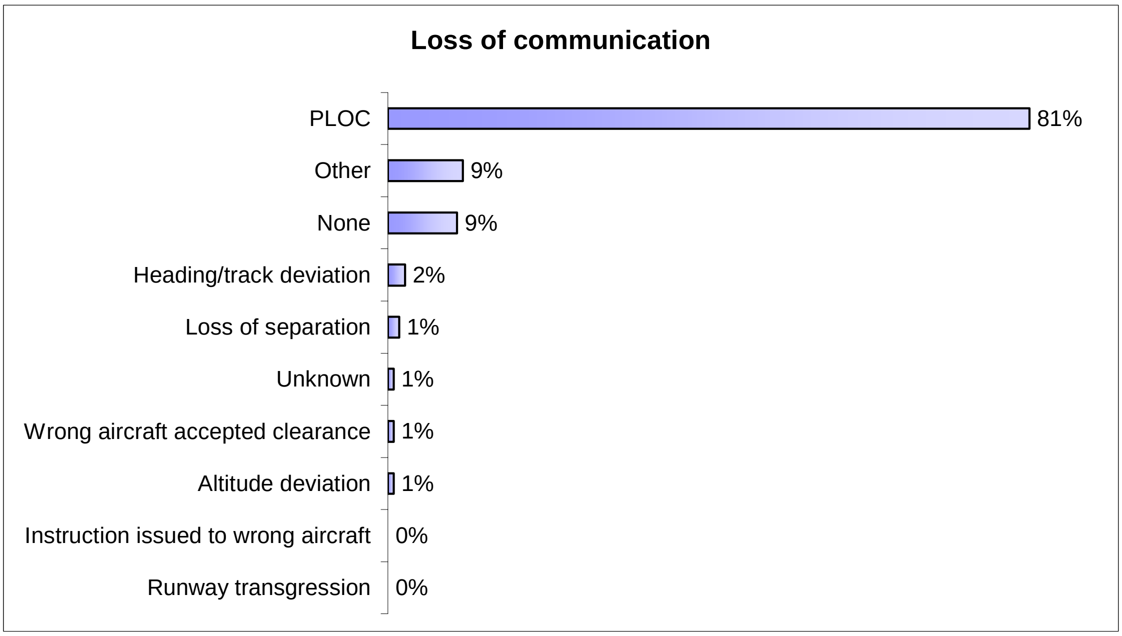

Figure 9: Consequences of loss of communication.

3.4 Results of the category ‘readback/hearback error’

In 52 of the 535 occurrences, the communication problem concerned a readback/hearback error. Figure 10 shows the distribution by flight phase of these occurrences.

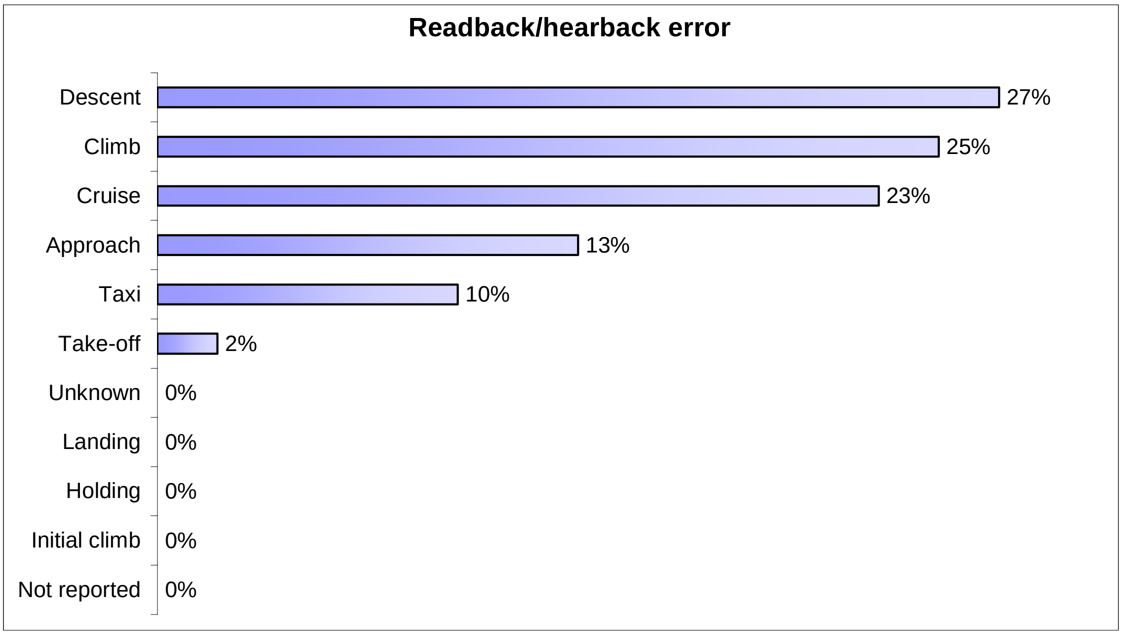

Figure 10: Distribution by flight phase of the occurrences involving a readback/hearback error**.**

Figure 11 gives an overview of the contributing factors reported in the readback/hearback error occurrences. Note that more than one factor could be assigned to one occurrence. A similar call-sign was the most common factor in this type of communication problem.

A detailed analysis was carried out on the main factors leading to ‘readback/hearback error’ occurrences as far as reporters had provided details in the reports[5]. Examples of occurrence reports in this category of communication problem are:

- *“Pilot misunderstands correct frequency and reads back wrong frequency*”
- “*Wrong aircraft accepted clearance, ATC did not notice, other aircraft detected the error*”.

An incorrect readback was reported in 15 of the 52 ‘readback/hearback error’ occurrences, while in 11 of those 15 cases the incorrect readback was not detected by the controller. The remaining 37 occurrences contained no meaningful information for further analysis. It is remarked that a similar call-sign was mentioned as a factor in 19 of the 52 occurrences (37%). The occurrences in which a similar call-sign was reported as a factor are events in which there was call-sign confusion and/or an aircraft accepted an instruction meant for another aircraft. Figure 12 shows the consequences of ‘readback/hearback error’

[5] Besides selecting the factors from the list in Table 1, they could also provide explanations in the comment box of the reporting form.

occurrences. In many cases these occurrences resulted in an altitude deviation or in an aircraft accepting a clearance meant for another aircraft.

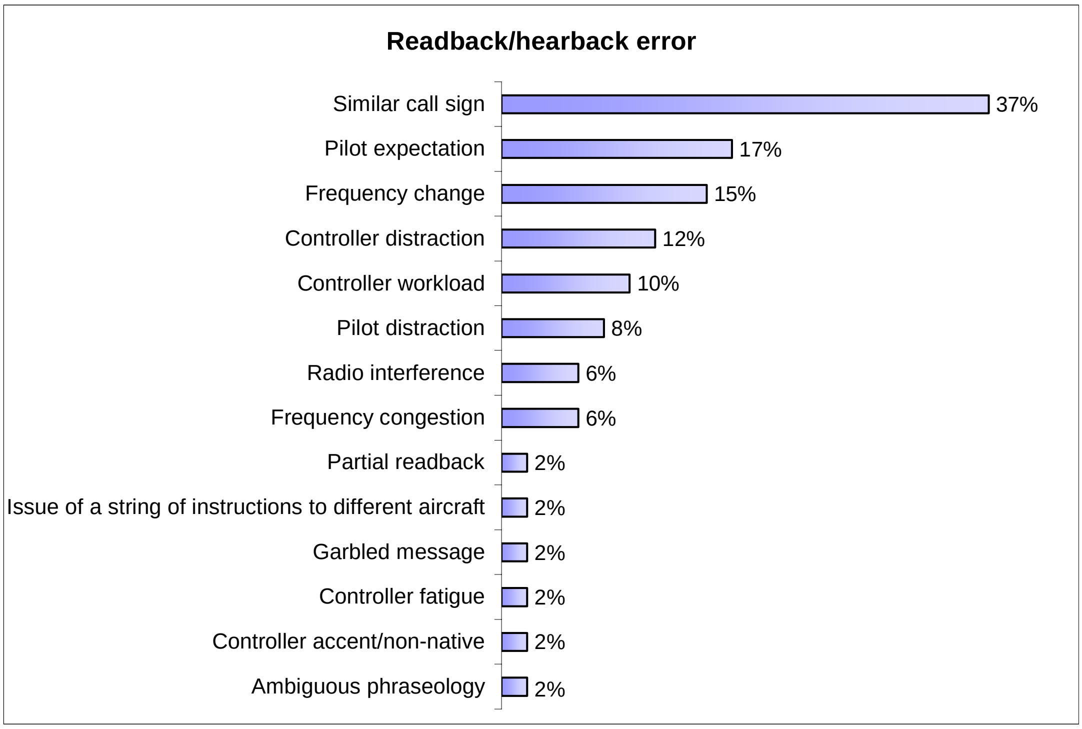

Figure 11: Contributing factors of the occurrences involving a readback/hearback error.

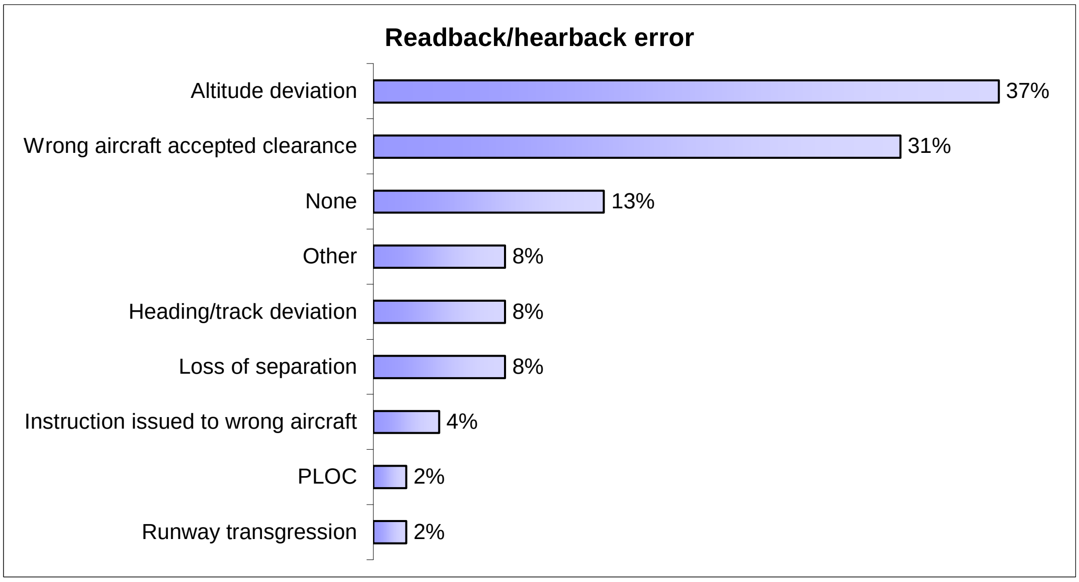

Figure 12: Consequences of the occurrences involving a readback/hearback error.

3.5 Results of the category 'communication equipment problem'

In 44 of the 535 occurrences the communication problem concerned the communication equipment. The distribution of those occurrences by flight phase is shown in Figure 13. Most communication equipment problems occur in the cruise. Figure 14 presents an overview of the factors contributing to the occurrences featuring a communication equipment problem. This study finds that the majority of the occurrences are the result of a radio malfunction in the aircraft. Some of these occurrences are possibly sleeping VHF receivers, but this factor was never reported in the occurrences involving a communication equipment problem. This is perhaps due to unfamiliarity of the reporters with the problem of sleeping VHF receivers.

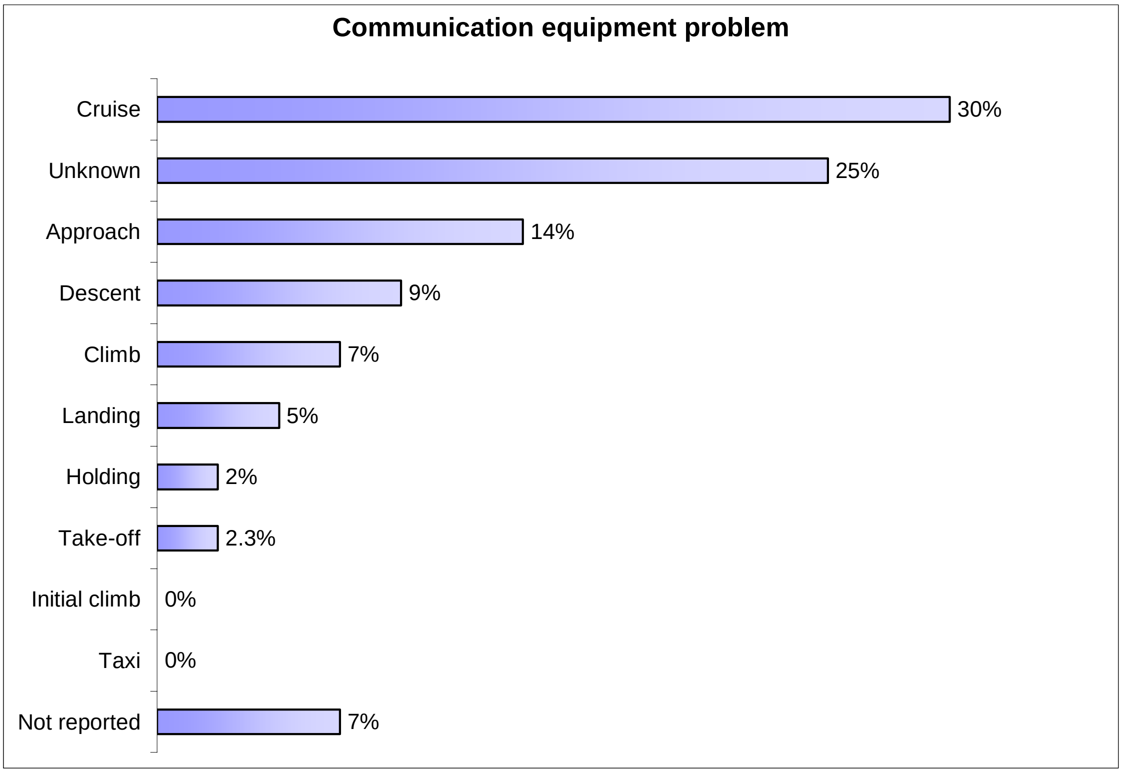

Figure 13: Distribution by flight phase of occurrences involving a communication equipment problem.

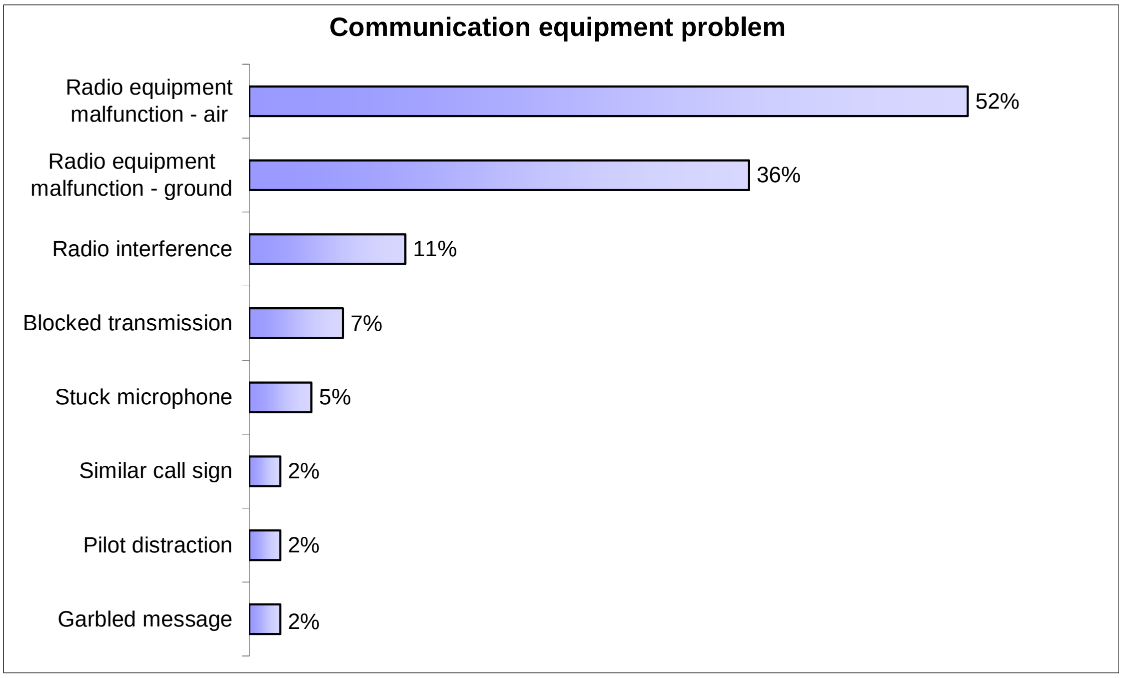

Figure 14: Contributing factors in occurrences involving a communication equipment problem.

A more detailed analysis was carried out on the main factors leading to a communication equipment problem as far as reporters had provided information in the occurrence reports[6]. Examples of occurrence reports in this category read: "*Radio malfunction for a couple of minutes before working again. Reason unknown*.", "*Voice communication system failure*" and "*Aircraft readable only now and then on return leg - probably caused by jammed radio switch".*

A radio equipment malfunction onboard the aircraft was reported in 23 (52%) of the 44 occurrences as is shown in Figure 14. Based on the available information in the occurrence reports it could be determined that 18 of these events were due to some type of communication equipment failure, 2 events were the result of a stuck mike, 2 events concerned a blocked frequency and one event involved poor radio communication quality (background noise).
In the 16 occurrences classified as a radio equipment malfunction on the ground, it appears that in 4 occurrences the radio communication quality was poor ('poor frequency'). In 9 of the 16 occurrences the reporters indicated that there were problems with the voice communication system without specifying the exact nature of the problems. In 3 occurrences no additional information was given.

Figure 15 shows the consequences of the occurrences with a communication equipment problem. About a third of the occurrences had no consequence. This can be explained by the availability of redundant equipment onboard and on the ground, e.g. second radio set or another frequency. Prolonged loss of communication is the second most cited consequence.

[6] Besides selecting the factors from the list in Table 1, they could also provide explanations in the comment box of the reporting form.

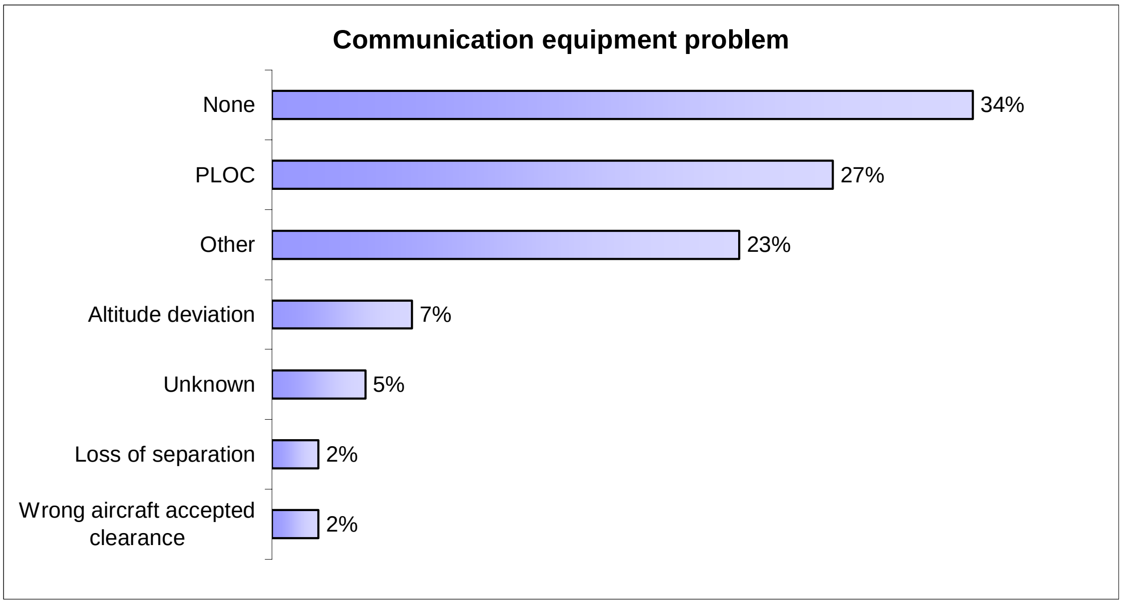

Figure 15: Consequences of the occurrences involving a communication equipment problem.

3.6 Results of the category 'no pilot readback'

This study found only five occurrences concerning no pilot readback in the data sample which is insufficient to analyse and draw meaningful conclusions that are statistically reliable.

3.7 Results of the category 'hearback error'

This study found only six occurrences involving a hearback error in the data sample, which is insufficient to analyse and draw meaningful conclusions that are statistically reliable.

3.8 Results of the category 'other communication problem'

The electronic reporting form used in the occurrence reporting campaign contained the category 'other communication problem'. This category was meant to report occurrences which did not fit into one of the five types of communication problems or which could not be classified due to a lack of information. 194 of the 535 reported occurrences come under this category. Figure 16 shows the distribution by flight phase of the occurrences involving an 'other communication problem'. Clearly, most of them occur in the cruise.

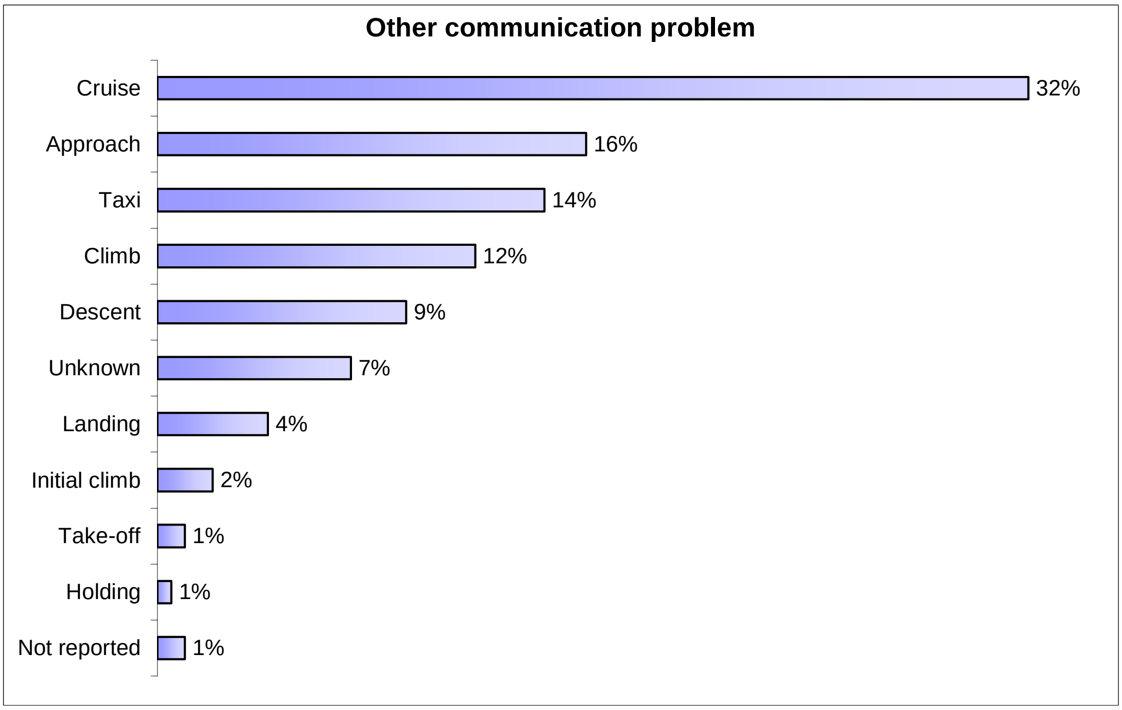

Figure 16: Distribution by flight phase of the category 'other communication problem'.

Figure 17 depicts the contributing factors associated with the occurrences concerning an 'other communication problem'. This study finds that the majority of the occurrences involve similar call-signs. A more detailed analysis was carried out on the main three contributing factors, as far as reporters had provided more information in the occurrence reports[7]. Examples of reports read:

- *"Three aircraft with similar call-signs are confusing ATCo"*
- *"There was some noise on frequency"*

[7] Besides selecting the factors from the list in Table 1, they could also provide explanations in the comment box of the reporting form.

- *"When crew realised that they had to be transferred, they contacted ATC. However, they were not able to obtain an answer. Therefore, crew changed to new frequency (published frequency on nav chart) themselves."*

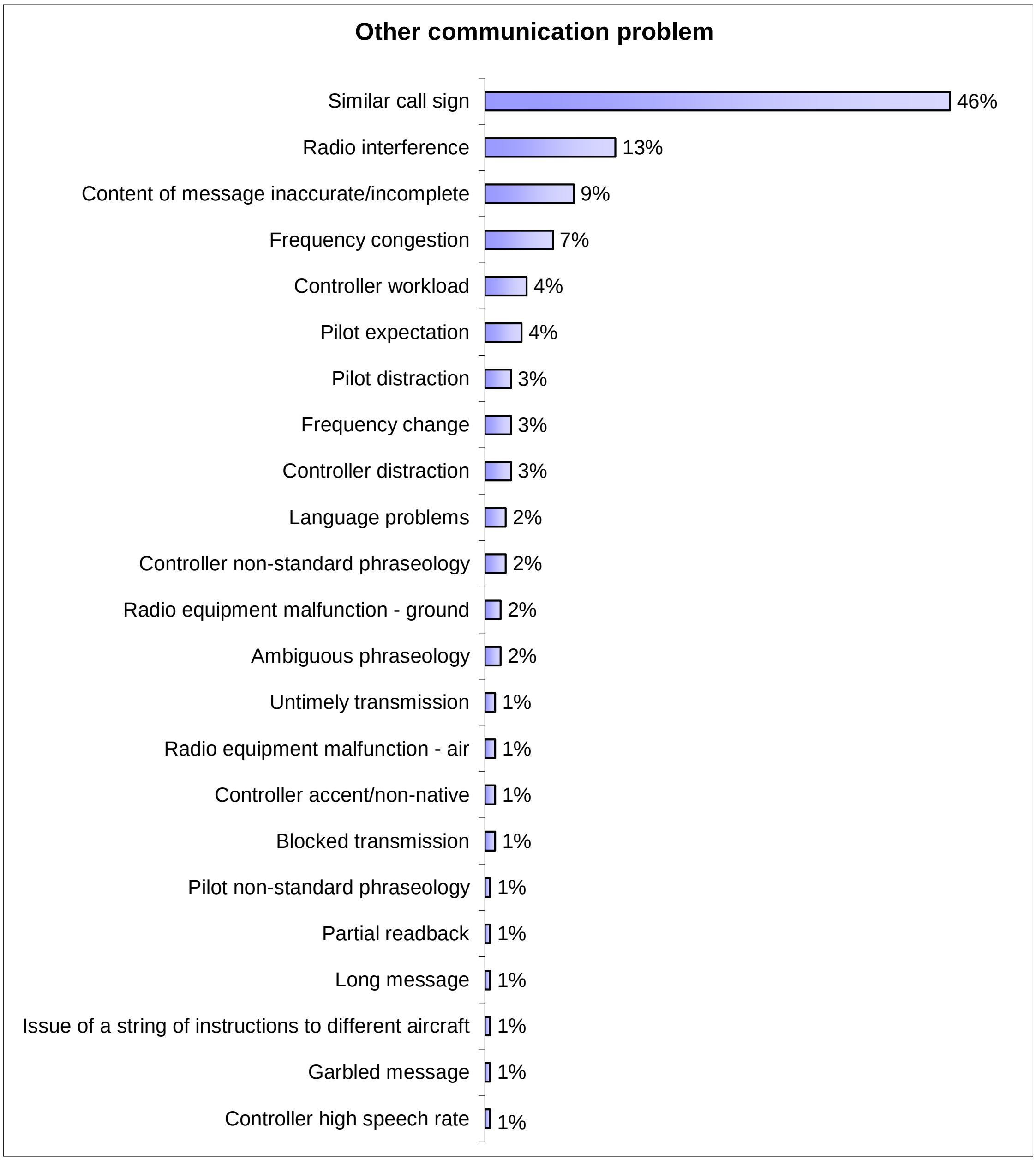

Figure 17: Contributing factors of the occurrences involving an 'other communication problem'.

Similar call-sign problems in the category 'other communication problem'

Figure 17 shows that many occurrence reports in the category 'other communication problem' concern similar call-signs, which can be a source of confusion and misunderstanding, as is illustrated by the following example.

> ABC412E departing from LIRA during his first call, first used an abbreviated call-sign (ABC412), whilst there was another active flight with call-sign ABC412, and later accepted a clearance for ABC410. When pilot realized a misunderstanding had occurred with 410 he reported to the controller. At this time the controller was still convinced to talk with ABC412 so changed the flight to the sector expecting ABC412 at 310. Here there was another call-sign confusion since ABC412E called omitting again the "E".

The consequences of the 'other communication problem' occurrences involving similar call-signs are specified in Table 7. It appears that the most common consequence is 'none'. This can be explained by the fact that in some cases the crew reported that they flew in a sector with aircraft with similar call-signs. Although such an event did not have a consequence, the crew indicated that such a situation could potentially cause misunderstandings, confusion etc. This is a typical example of an occurrence report in the category 'other communication problem' with factor 'similar call-sign' and no consequence.

The consequence category 'other' contains 18 occurrences. Confusion in communication due to similar call-signs was reported in 12 of the 18 occurrences, while in 6 occurrences similar call-signs were reported out of concern (no confusion had taken place).

Table 7: Consequences reported in the occurrences involving 'other communication problems' with factor 'similar call-sign'.

Consequence	**Occurrences**
None	56
Other	18
Instruction issued to wrong aircraft	7
Unknown	6
Wrong aircraft accepted clearance	5
Altitude deviation	2
Runway transgression	1
Prolonged loss of communication	0
Loss of separation	0
Heading or track deviation	0

Radio interference problems in the category 'other communication problem'

Figure 17 shows that the factor 'radio interference' was assigned to 25 (13%) occurrences. It was determined that 10 of these occurrences concerned poor quality of the radio frequency (for unknown reason), 4 occurrences were related to radio interference from music stations, 4 were related to telephone interference, and 7 occurrences were unspecified.

Inaccurate message problems in the category 'other communication problem'

Figure 17 shows that 'content of message inaccurate' was cited as a factor in 9% of the occurrences involving an 'other communication problem'. Analysis revealed that this factor was mentioned twice in combination with a frequency change problem. Other factors mentioned in combination with 'content of message inaccurate' are controller accent/non-native, controller distraction, controller fatigue, controller high speech rate, controller non-standard phraseology, controller workload, frequency congestion and garbled message.

Figure 18 shows the consequences of the occurrences involving an 'other communication problem'. Almost half of the occurrences in this category did not have any consequence (49%).

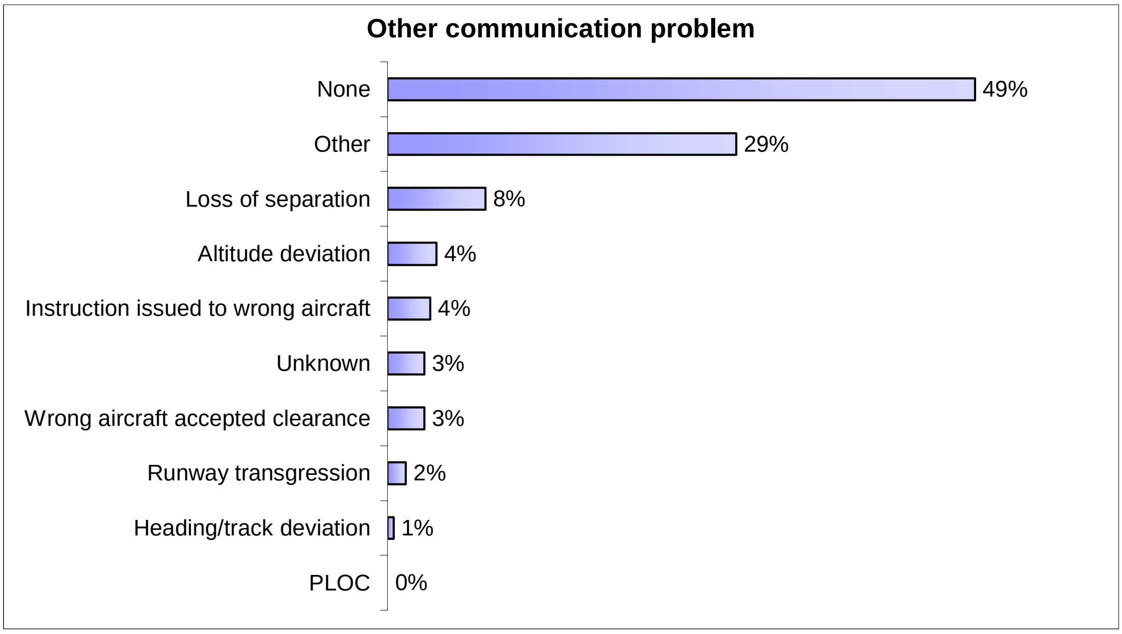

Figure 18: Consequences of the occurrences involving an 'other communication problem'.

3.9 Results of the category 'type of communication problem not reported'

In the data sample 97 occurrence reports were found in which the type of communication problem was not reported for some reason. Nevertheless, some information could be derived from other fields which were filled out in the reporting form in those occurrences. Figure 19 shows the distribution by flight phase of the occurrences in which no communication problem was reported. The cruise accounts for most of these occurrences. The contributing factors in the occurrences with no reported problem are shown in Figure 20. Similar call-signs are by far the most cited factor (62; 64%). It is likely that these occurrences refer to communication problems concerning similar call-signs, while the reporters forgot to or chose not to mark one of the six categories for type of communication problem in the reporting form. A more detailed analysis could not be carried out because reporters did not provide enough details in the comment box on the occurrence reporting forms.

Figure 21 presents the distribution of the consequences of the occurrences in which no communication problem was reported. The majority of these occurrences had no consequence. Note that more than one consequence could be assigned to a single occurrence. This study finds that the majority of the occurrences, in which similar call-signs were reported as a contributing factor, have no consequence (47 of 62 occurrences). Other consequences of the occurrences where similar call-signs were reported are: instruction issued to wrong aircraft (9), wrong aircraft accepted clearance (8) and one runway transgression and one loss of separation. In 5 occurrences the combination 'wrong aircraft accepted the instruction' and 'the instruction was issued to the wrong aircraft' was reported.

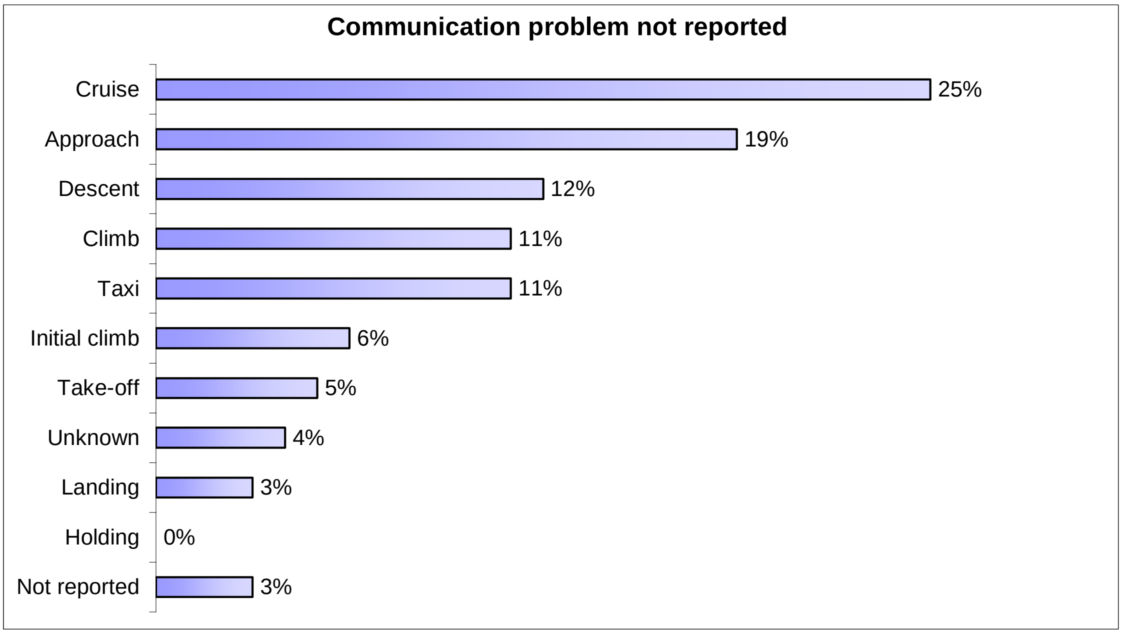

Figure 19: Distribution by flight phase of the occurrences in which the type of communication problem was not reported.

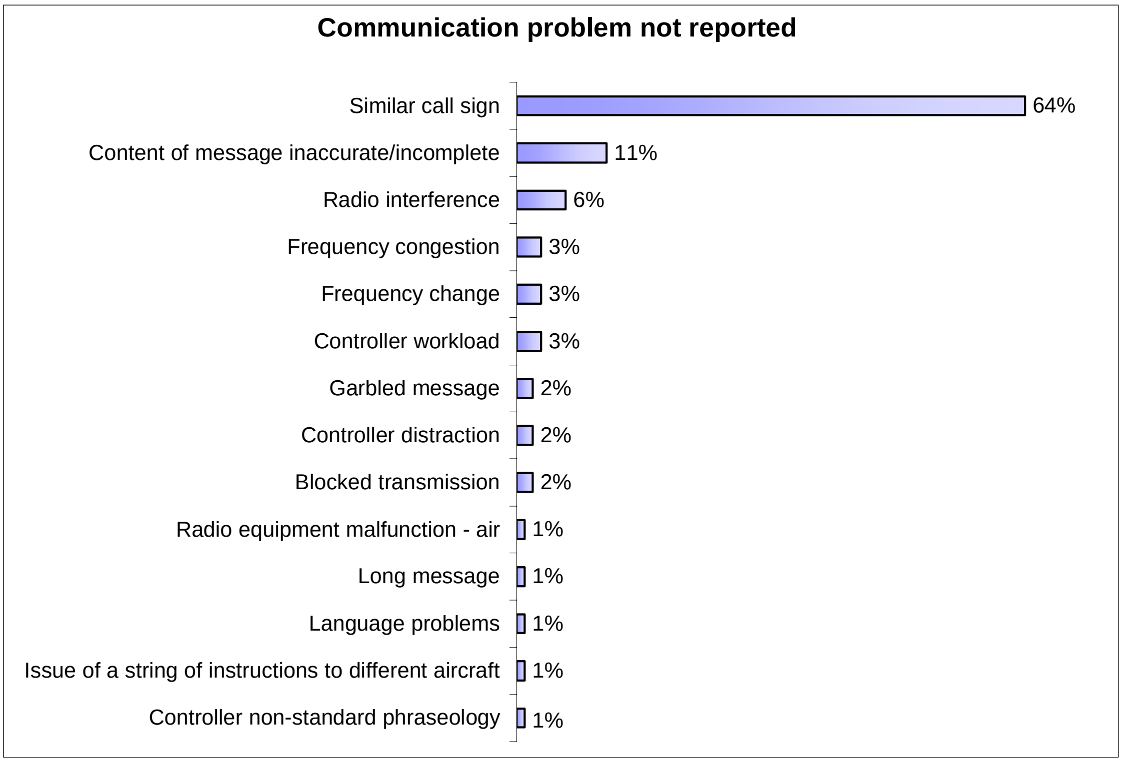

Figure 20: Contributing factors of the occurrences in which the type of communication problem was not reported.

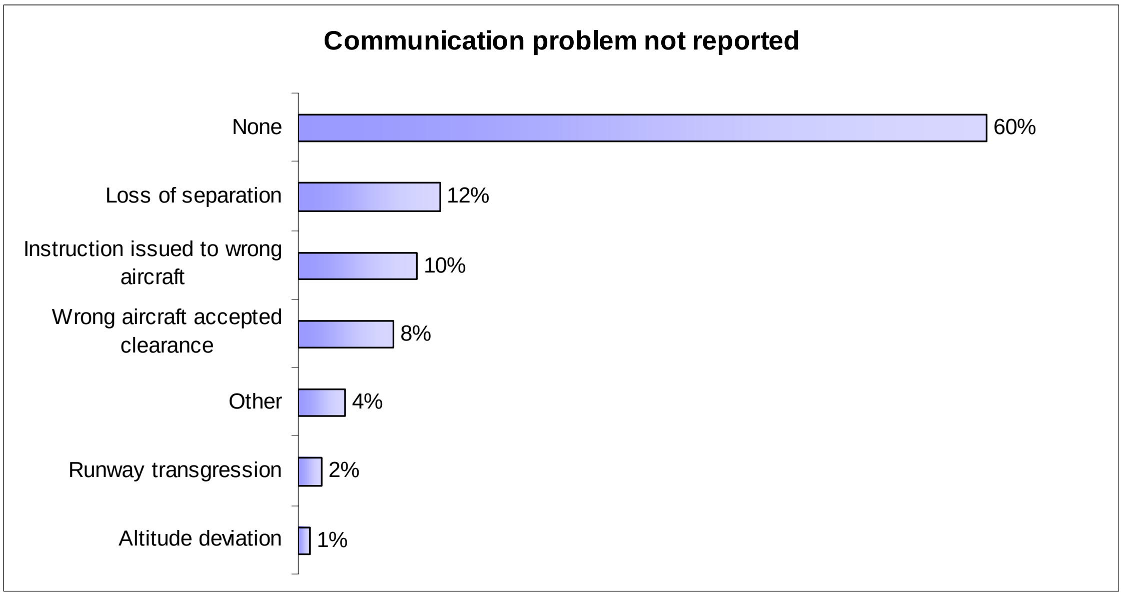

Figure 21: Consequences of the occurrences in which the type of communication problem was not reported.

Chapter 4
Results of the survey of pilots and air traffic controllers

4.1 Introduction

The survey of professional pilots and air traffic controllers was held with the objective of deriving lessons learnt and safety recommendations on six communication problems. The questionnaire addressed the following types of communication problems: similar call-signs, sleeping VHF receivers, frequency change, non-standard phraseology, blocked transmission and radio interference. Pilots and controllers were asked to provide frequency estimations and contributing factors with respect to the surveyed communication problems. In addition, they offered a wide variety of lessons learnt, comments and suggestions for safety improvements. (Refer to section 2.4 for more information).

This chapter will present the results of the analysis of the responses that were offered by pilots and controllers in the survey questionnaire. First the background of the participants is presented in section 4.2. The subsequent sections address similar call-signs (4.3), sleeping VHF receivers (4.4), frequency change (4.5), non-standard phraseology (4.6), blocked transmission (4.7) and radio interference (4.8).
Each section presents the frequency estimation and contributing factors cited by the pilots and controllers, and contains a summary of the recommendations by pilots and controllers to mitigate or tackle the associated communication problem.

4.2 Background of the survey participants

In total 344 persons participated in the survey. The distribution of the participants between pilots and air traffic controllers is 308 pilots (90%) and 36 controllers (10%). In the population of pilots 52% hold the rank of captain, 42% are first officers and the remaining 6% are second officers. The majority of the participating pilots fly long-haul sectors (79%), while the remainder (21%) conducts short-haul flights. This is reflected in some of the comments by pilots on communication problems. For example, pilots flying long-haul routes often reported their experience with communication problems in South America, Africa, the Far East and the United States of America. The present study analysed the entire set of comments and recommendations to get a good overview, but limited the summary of the recommendations to those that are deemed relevant for the European situation.

The experience of the participating pilots is shown in Table 8. It is concluded that the group of professional pilots is a representative sample, based on the distribution of pilots over long- and short-haul, their average flying experience and rank distribution.

Table 8: Experience of the participating pilots.

Total flight hours	**Hours**	**Flight hours in past 12 months**	**Hours**	**Sectors flown in past 90 days**	**Sectors**
On average	7482	On average	579	On average	53
Standard deviation	4628	Standard deviation	184	Standard deviation	58
Maximum	20000	Maximum	900	Maximum	600
Minimum	10	Minimum	0	Minimum	0

The participating air traffic controllers are active in the different areas of ATC, as is shown by Figure 22. The experience of the group of air traffic controllers is presented in Table 9. It is concluded that the group of controllers is representative based on their experience, the number of aircraft handled hourly and the different ATC roles. Air traffic controllers are underrepresented in the survey compared to the size of the group of participating pilots. However, the recommendations from air traffic controllers are not affected by their population size in the survey and are thus considered as valuable as those submitted by the pilots.

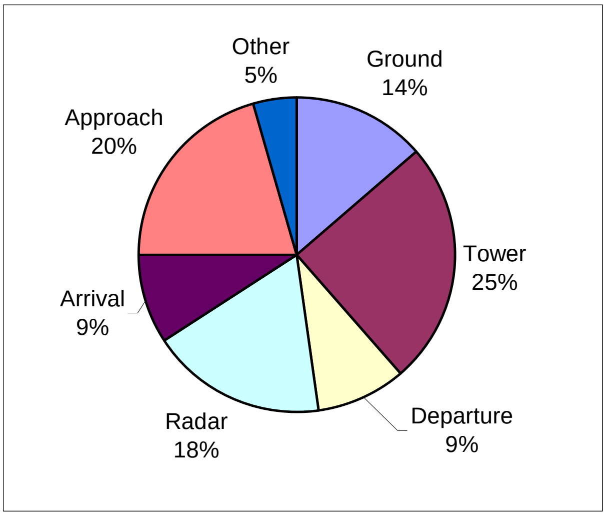

Figure 22: Distribution of participating air traffic controllers in different air traffic control roles.

Table 9: Experience of the participating air traffic controllers.

Working experience	Years	Man-hours per year	Hours	Number of aircraft handled	Per Hour
On average	11.0	On average	1449	On average	16.0
Standard deviation	9.1	Standard deviation	604	Standard deviation	12.2
Maximum	32.0	Maximum	3000	Maximum	60
Minimum	1.0	Minimum	2	Minimum	3

Figure 23 shows the percentage of pilots and controllers, who commented in the questionnaire on the different types communication problems. This figure gives an idea on how well each type of communication problem was covered in the survey.

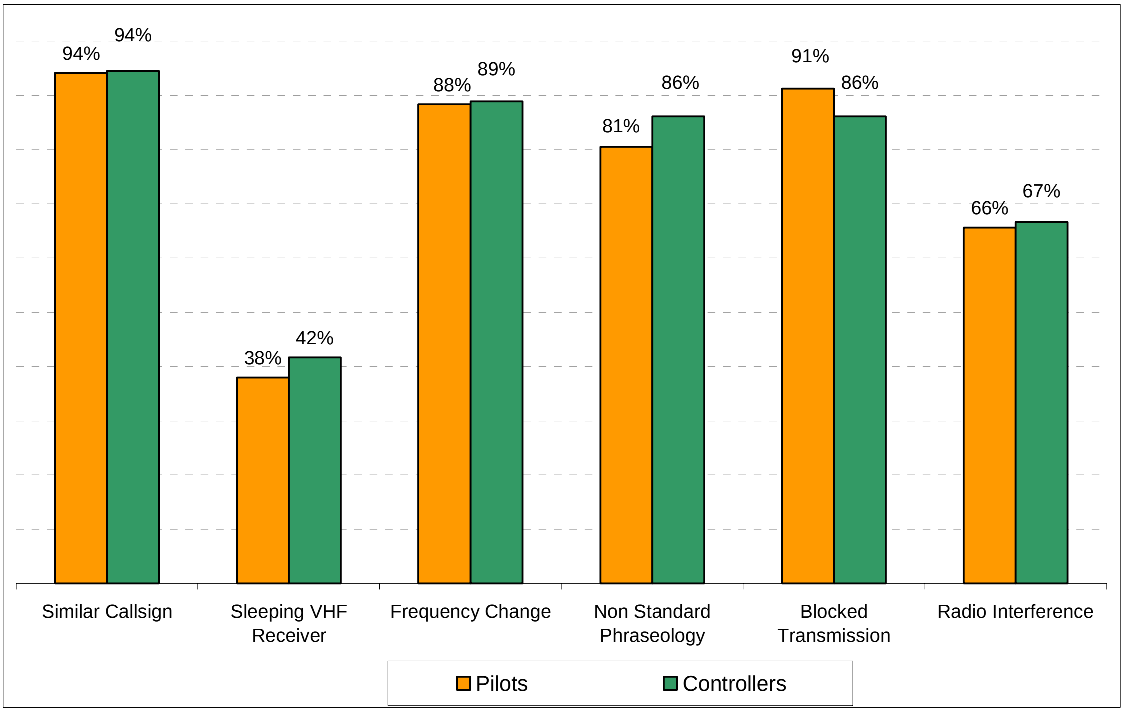

Figure 23: Percentage of pilots and controllers giving feedback on the different types of communication problems.

4.3 Response from pilots and controllers on similar call-signs

4.3.1 General

The problem of similar call-signs was widely recognised by the survey participants and triggered a lot of critique and recommendations. In total 241 participants provided comments and safety recommendations in the area of similar call-signs. The problem of similar call-signs is on the one hand related to human factors (e.g. mixing up call-signs because they 'look'/sound similar) and R/T skills (e.g. pronunciation of numbers, speech rate and accent). These issues are an inevitable part of voice communication. The similar call-sign problem is on the other hand caused by the way call-signs are assigned and their structure, i.e. company name (abbreviation) and a series of numbers. Most airlines use logic in assigning call-signs to flights, e.g. call-signs are based on the destination of the flight (continent, outbound, inbound, city). As a result it happens that aircraft depart for the same general destination and follow the same routes having similar call-signs.

4.3.2 Subjective frequency estimation and causal factors

Figure 24 shows the frequency estimation by pilots and controllers with which they experience a communication occurrence involving similar call-signs. The figure shows that 20% of all respondents indicate they experience this type of communication problem once a week. Most respondents (about 40%) report that they encounter this problem on average once a month. The frequency estimation by pilots and controllers shows a similar trend, which means that they are evenly exposed to the problem.

The survey participants could also assign contributing factors to this type of communication problem in the survey questionnaire. The frequency of the factors that contributed to the 'similar call-sign' occurrences according to pilots and controllers is shown in Figure 25. The most often cited contributing factors in communication problems involving similar call-signs are related to human factors:

- Controller accent (34% [8])
- Controller speech rate (28%)
- Pilot distraction (25%)
- Pilot expectation (22%)
- Pilot fatigue (20%)

Two other factors which are common are frequency congestion (28%) and blocked transmission (30%). When a frequency is congested, pilots await every opportunity to insert their message or respond to ATC calls. Similarly, a controller will be anxious to respond to messages as expeditiously as possible. As a result both pilot and controller may 'respond before thinking' to a call for a similar call-sign. When a transmission is stepped upon (blocked transmission), the normal check on the readback may be missed due to the interfering

[8] The percentage refers to the number of respondents citing the factor divided by the total number of respondents who experienced a communication problem with similar call-signs.

transmission. An erroneous response on a similar call-sign may in such cases go uncorrected.

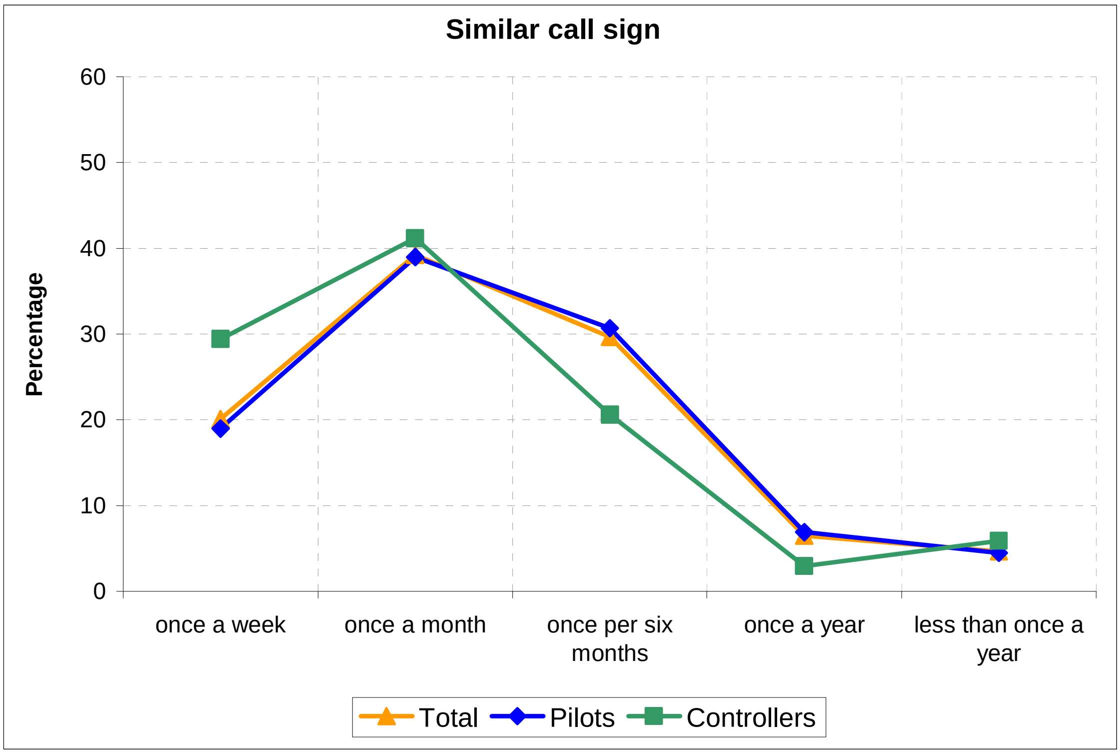

Figure 24: Frequency of communication problems with similar call-signs estimated by pilots and controllers.

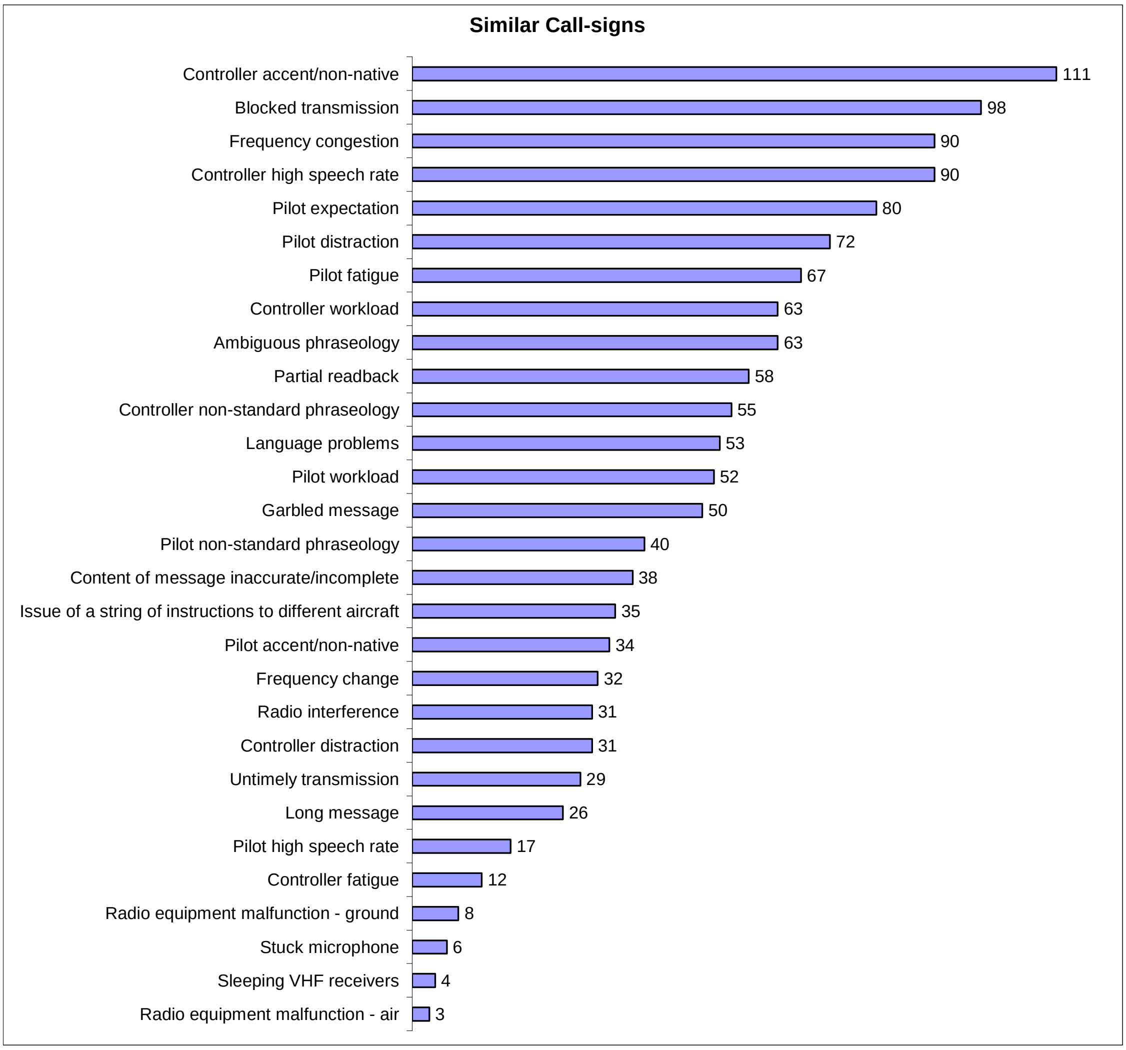

Figure 25: Factors in communication problems involving similar call-signs cited by pilots and controllers.

4.3.3 Examples of responses by pilots and controllers

[Airline X] gives all African flights a 5xx call-sign. Even the second digit is based on area within the continent. I.e. Nairobi being a [Airline X] 565 and Kilimanjaro a [Airline X] 569 (just a few miles further). Therefore every [Airline X] aircraft in Africa (and in your area) has a similar call-sign. Terrible transmitters in certain areas of the world are, in combination with similar call-signs and bad English (accents), the feeding ground for approx 95% of the problems. Even different carriers sometimes have coincidentally the same flight number. The flight number is most important, because the accents usually make the airline unreadable anyway... So [Airline Y]555 in Africa sounds the same as [Airline X]555. The controllers SHOULD change call-signs when they sound the same... but this never happens.
[Pilot 274]

> The only way to combat this at the moment from the pilot's perspective is to confirm with the controller exactly who the instruction was for if unsure - this adds to workload for controllers on busy frequencies. Hopefully controllers are pro-active in spotting similar call-signs and alerting authorities to prevent problems. However, airlines, including my own don't seem to appreciate the problem they are causing by having very similar call-signs amongst their own aircraft sometimes. Ours only changes call-sign name if ATC asks them to!! Airlines should put more thought into call-signs of their own aircraft transmitting the same airspace.
> [Pilot 25]

> Similar call-signs may be confusing to both those transmitting and receiving instructions. Such incidents may be prevented by issuing temporary call-signs such as registrations of aircraft etc.
> [Air traffic controller 135]

> Abolish company practice to have similar call signs operate in the same time frame. Looks good on paper but causes problems in actual operation.
> [Pilot 213]

> Automated flight plans that do not allow acceptance into the system because of same call-signs etc
> [Pilot 75]

> Different types of call-sign (numbers only, alphanumeric, ...) need to be used as a strategic mitigation, pilots and controllers need to clearly enunciate call-signs and need to speak slowly enough and with sufficiently long breaks in between words or message parts, messages must not contain more than two elements apart from the call-sign.
> [Pilot 111]

4.3.4 Summary of recommendations by pilots and controllers

The recommendations by the survey participants with respect to similar call-signs are on a high level related to R/T skills, call-sign assignment and technology.

R/T skill

Many survey participants believe that improvement of R/T skill and discipline will help to reduce the problem with similar call-signs. The following list of recommendations was offered by pilots and controllers to improve the quality of communication in general and especially similar call-signs.

Recommendations for pilots:

- Use standard phraseology.
- Use English language only.
- Do not use abbreviations: the call-sign should include flight number and company name.
- Accentuate important words/syllables: e.g. [company name] five SIX zero.
- Ask for confirmation if in doubt.
- Check flight plans for similar call-signs and brief pilots when they should expect similar call-signs.
- When encountered report similar call-signs to controllers.

Recommendations for air traffic controllers:

- Use standard phraseology.
- Use English language only.
- Do not use abbreviations: call-sign should include flight number and company name.
- Accentuate of important words/syllables: e.g. [company] five SIX zero.
- Inform flight crews when aircraft operate with similar call-signs in the same airspace (on the same frequency).
- Issue temporary call-signs when aircraft operate with similar call-signs in the same sector at the same time.
- Pay attention to the flight crew readback. In general a good readback/hearback discipline should catch errors and misunderstanding about clearances and call-signs.
- Speak slowly, in a steady rate and clearly, when giving instructions, including the pronunciation of the call-sign.

Call-sign assignment by operators

Many survey respondents suggested to change the way call-signs are assigned to flights/destinations or to change the call-sign when similar call-signs are encountered en-route. A summary of their recommendations on this topic is listed below:

- Use alphanumeric call-signs, i.e. call-signs consisting of a number-letter combination. Examples are KL 56B, Easyjet A45.
- Use aircraft registration as call-sign.
- Use a short call-sign, a two or three digit call-sign at most. This could be easier to remember and gives less opportunity for mistakes.
- Repeat the company name twice, either before or after the call-sign. Examples are KLM 123 KLM or Easyjet Easyjet 456.
- The full complete call-sign should always be used in communication. The call-sign should not be abbreviated and the company name should not be left out. For example if the call-sign is KL 4567, it should be KL 4567 and not 456 or 4567 or KL 456 or KL 567.
- In the United States a different way of pronouncing the numbers (namely in blocks of two) in the call-sign has recently been introduced: KL621 becomes “SIX-TWENTY-ONE” and United 1263 becomes “TWELVE-SIXTY-THREE”, which reduces the likelihood that call-signs are similar.
- Airlines should randomise call-signs instead of using certain logic to assign call-signs to flights. This would reduce the likelihood that flights have similar call-signs when they are in the same airspace.
- A systematic analysis of call-signs should be carried out so that similar call-signs can be identified and changed for instance into alphanumeric call-signs. The analysis requires co-operation between airlines and also requires support from the regulatory organisations (ICAO, NAA, and EUROCONTROL).

Technology

In the area of technological improvements the survey participants are hopeful and optimistic about a data link between aircraft and ground. This could be a big step forward to prevent call-sign confusion, especially because part of the call-sign confusion stems from the pronunciation of call-signs, the controller speech rate and R/T quality (noise) according to the pilots and controllers. Improvement of transmission equipment and the use of noise suppression headsets are recommended by some respondents to help improve the quality of the R/T transmissions and the ease of hearing what is said.

4.4 Response from pilots and controllers on sleeping VHF receivers

4.4.1 General

Note: The definition of 'sleeping VHF receiver' used in the survey reads "loss of communication type in which the VHF frequency becomes silent for a period of time". After the survey was conducted it was considered, by the EUROCONTROL Agency, that this definition might have been interpreted to cover all types of prolonged loss of communications (PLOC), rather than those specifically relating to the equipment problems which are sometimes characterised by the term "sleeping VHF receivers". The first and the last examples of responses in 4.4.3 support this consideration. Consequently, the following results and analysis are probably more useful if viewed as giving an insight into PLOC, and the narrative, tables, and graphs in this section have been labelled accordingly.

Comments and suggestions for the problem of PLOC[9] were offered by 78 participants (22%). Many participants regarded PLOC[9] occurrences as a problem of radio silence for undetermined reason or as a result of a frequency change problem. Most recommendations are therefore related to treating a radio silence, while not specifically addressing PLOC[9]. This is not surprising since the technical issues are outside the scope and influence of the survey participants.

4.4.2 Subjective frequency estimation and causal factors

Figure 26 shows the frequency estimation by pilots and controllers with which they experience a communication occurrence involving PLOC[9]. About a quarter of the controllers experience this type of problem weekly, while 40% says it happens once per six months.

In the survey questionnaire the participants could assign contributing factors to the occurrences of this type of communication problem. Figure 27 shows the frequency of factors as reported by the pilots and controllers in the survey. The following contributing factors are the most common:

- Frequency change (28% [10])
- Blocked transmission (23%)
- Radio equipment malfunction – ground (20%)
- Stuck microphone (19%)
- Radio equipment malfunction – air (17%)

[9] See Note at the beginning of this section.

[10] The percentage refers to the number of respondents citing the factor divided by the total number of respondents who experienced a communication problem with a PLOC.

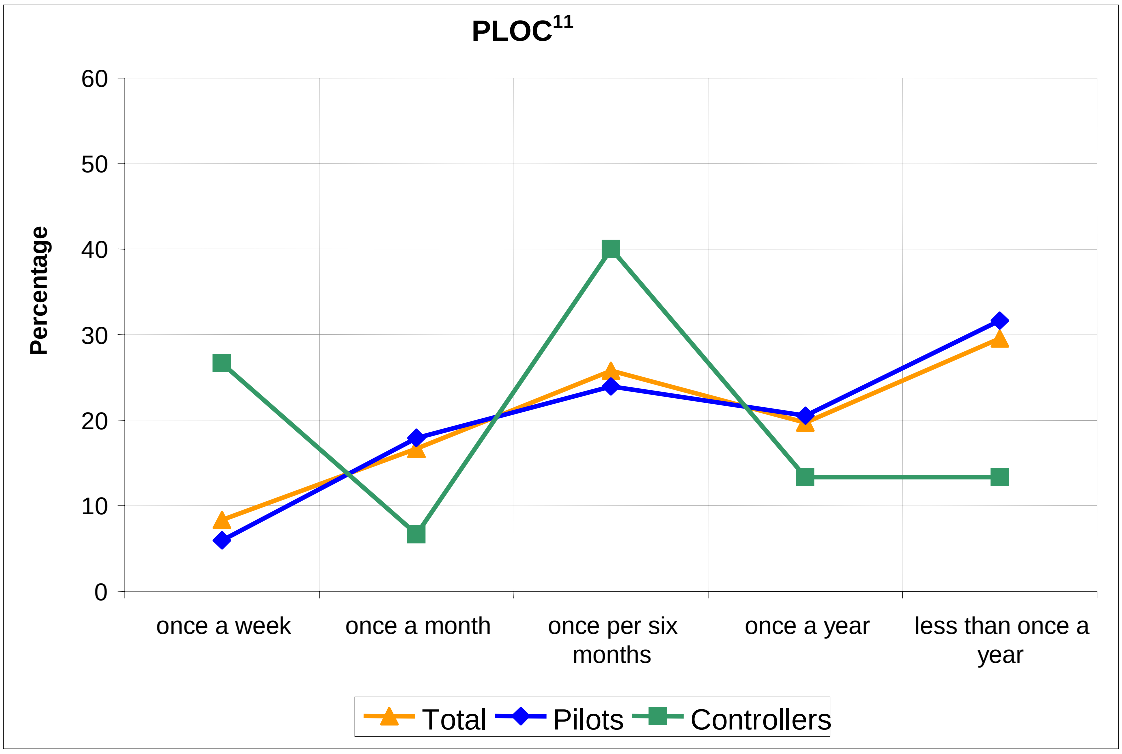

Figure 26: Frequency of communication problems with PLOC[11] estimated by pilots and controllers.

[11] See Note of the beginning of this section

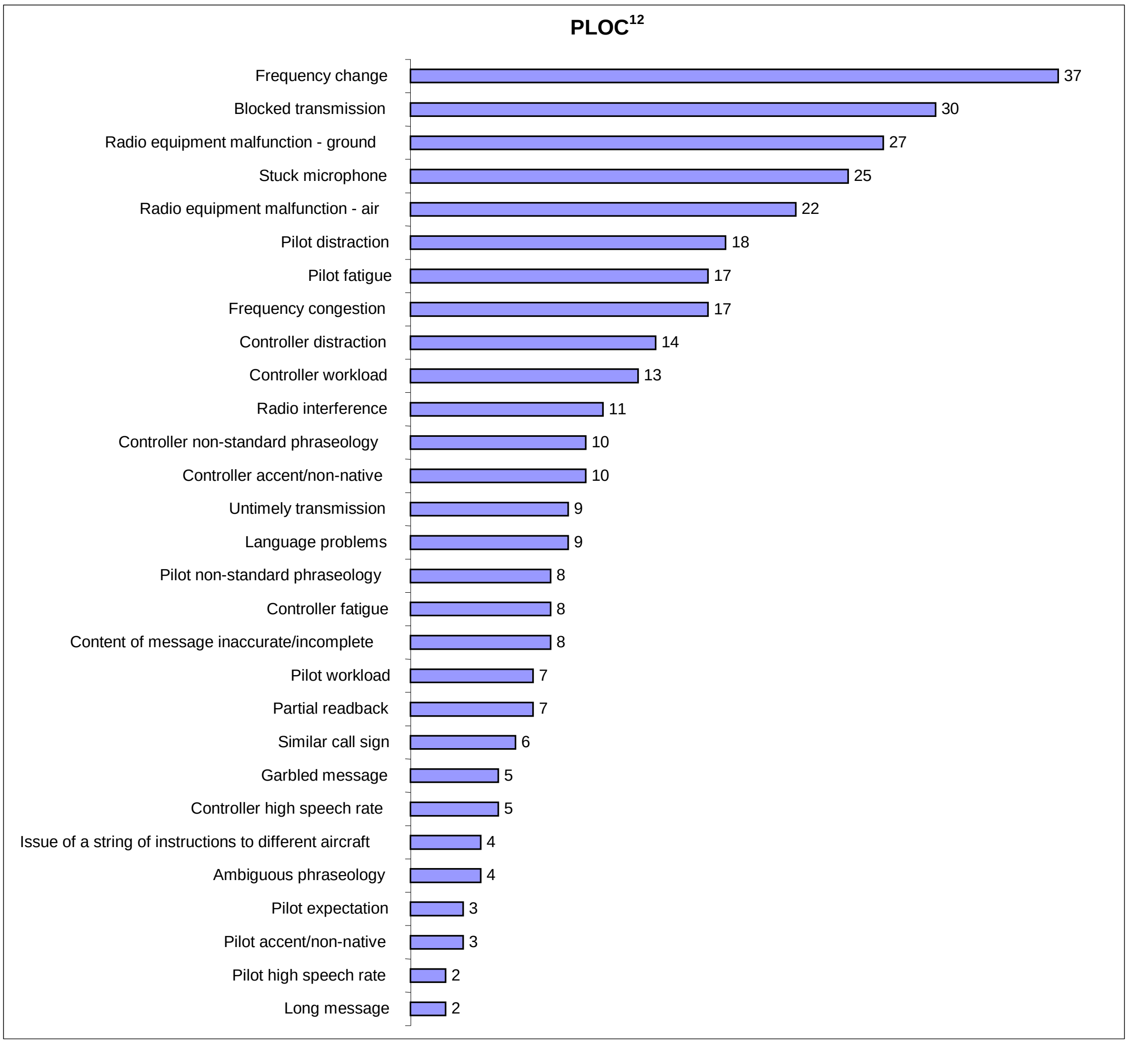

Figure 27: Factors in communication problems involving PLOC[12] cited by pilots and controllers.

[12] See Note of the beginning of this section

4.4.3 Examples of responses from pilots and controllers

Our flight from [country X] to [country Y in Europe] departs late in the evening local [country X] time. It is the longest flight we do on my aircraft type. Sometimes the flight time is over 13 hours. When we were flying over [country Z in Europe], the captain was asleep in the crew rest and the first officer sitting next to me (who did radio communications as pilot-not-flying) wanted to take a nap in the cockpit before landing. This is legally allowed under [country Y] law. During cruise flight we usually have the speakers (for ATC communication) turned on and sometimes we wear the headset, sometimes we don't. We decided to turn off the speakers and I put on my headset so the first officer could take his nap. When he woke up again I told him I would go to the toilet. About ten minutes after I came back to my chair (while we were making approach preparations) I noticed that the speakers were still turned off and we were both not wearing a headset! We informed ATC that there had not been communication for about 15 minutes... Off course the [country Z] controller was not amused; he said he "had called us several times". Next time, I will pay special attention to the cockpit speakers when somebody takes a nap. We felt very stupid about this mistake.
[Pilot 272]

Make a radio check from time to time and check when you expect the next transmission from ground
[Pilot 53]

In Scandinavia there isn't a lot of transmissions on the frequency. So a lot of silent time... When a controller forgets/is too late with handing you over to the next controller/frequency (so you get out of range), you simply don't notice it because of the long silent times. We got back into contact because another aircraft called us back over 121.5 and told us that "... control wants us to change to ..." Ever since I always have 121.5 on the secondary box. (I know it is pilot's mandatory instruction to listen out on 121.5, but experience shows me a lot of people forget it)
[Pilot 287]

Check transmission if you here nothing for a long time (eg 5 minutes), never shut a loudspeaker down before checking with other flight crew his speaker is on, confirm explicitly that you keep only selcall watch after selcall check, always watch 121,5 and inter-pilot, we naturally keep headset longer after take-off when at night or tired, plus we wear it early in descent.
[Pilot 2]

4.4.4 Summary of recommendations by pilots and controllers

With respect to the consequences of PLOC[13] the pilots and controllers recommend the following:

Recommendation for pilots:

- Monitor 121.5 MHZ at all times.
- Perform a radio check after a period of radio silence.
- Do not shut down the volume of the speakers when for example a passenger announcement is being made.

Recommendation for air traffic controllers:

- When no transmission has occurred for a certain period of time, the controller should check the frequency with a call-sign and "how do you read?"

[13] See Note of the beginning of this section

4.5 Response from pilots and controllers on frequency change

4.5.1 General

Approximately 50% of the survey respondents submitted lessoned learnt and suggestions to improve frequency changes and to avoid mistakes in this respect. The majority of the participants stressed the importance of appropriate R/T skills, such as the use of standard phraseology, single language (English), speaking slowly, good readback/hearback discipline etc. These elements are essential to clear communication. The survey also indicates that there is a lot of concern regarding the introduction of 8.33 KHz frequency spacing was introduced. As a result, the new frequencies are six digits long and together with long call-signs and other ATC instructions they are susceptible to mishearing and mistakes. It is also reported that the frequency quality has reduced.

4.5.2 Subjective frequency estimation and causal factors

Figure 28 shows the frequency estimation by pilots and controllers with which they experience a communication occurrence involving a frequency change. The figure shows that almost 40% of the respondents encounter a communication problem involving frequency change once a month. Controllers seem to encounter this problem more often than pilots. About 75% of the controllers experience frequency change related communication problems more than once a month, whereas about 60% of the pilots have a similar experience rate.

In the survey questionnaire the participants could assign contributing factors to the occurrences of this type of communication problem. The frequency of factors that contributed to this communication problem according to the pilots and controllers is shown in Figure 29. The five most common factors contributing to a frequency change problem are:

- Controller accent (51% [14]),
- Controller speech (42%),
- Pilot distraction (43%),
- Pilot fatigue (35%), and
- Pilot workload (31%).

The picture that emerges from this data is that one of the problems with frequency change is that the frequency issued by the controller may be hard to hear or is misunderstood by pilots due to controller's accent (language problem) and speech rate. Similarly, pilots may be distracted and forget to switch to a new frequency or select a wrong frequency.

[14] The percentage refers to the number of respondents citing the factor divided by the total number of respondents who experienced a communication problem with frequency change.

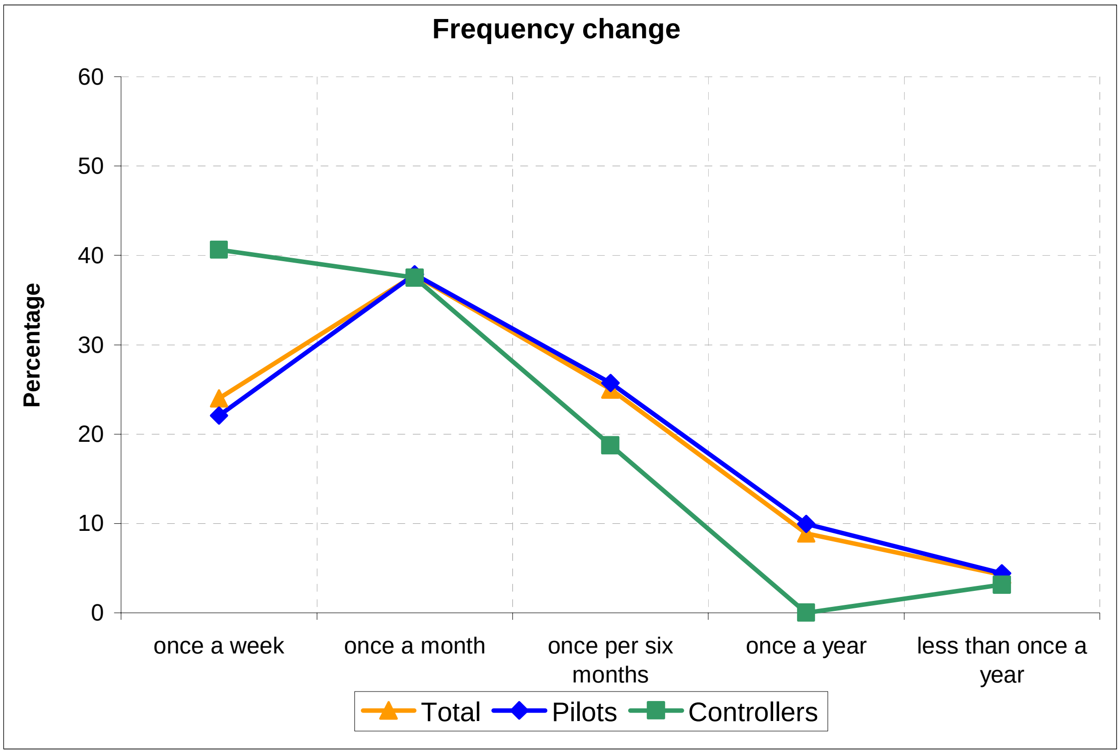

Figure 28: Frequency of communication problems with frequency change estimated by pilots and controllers.

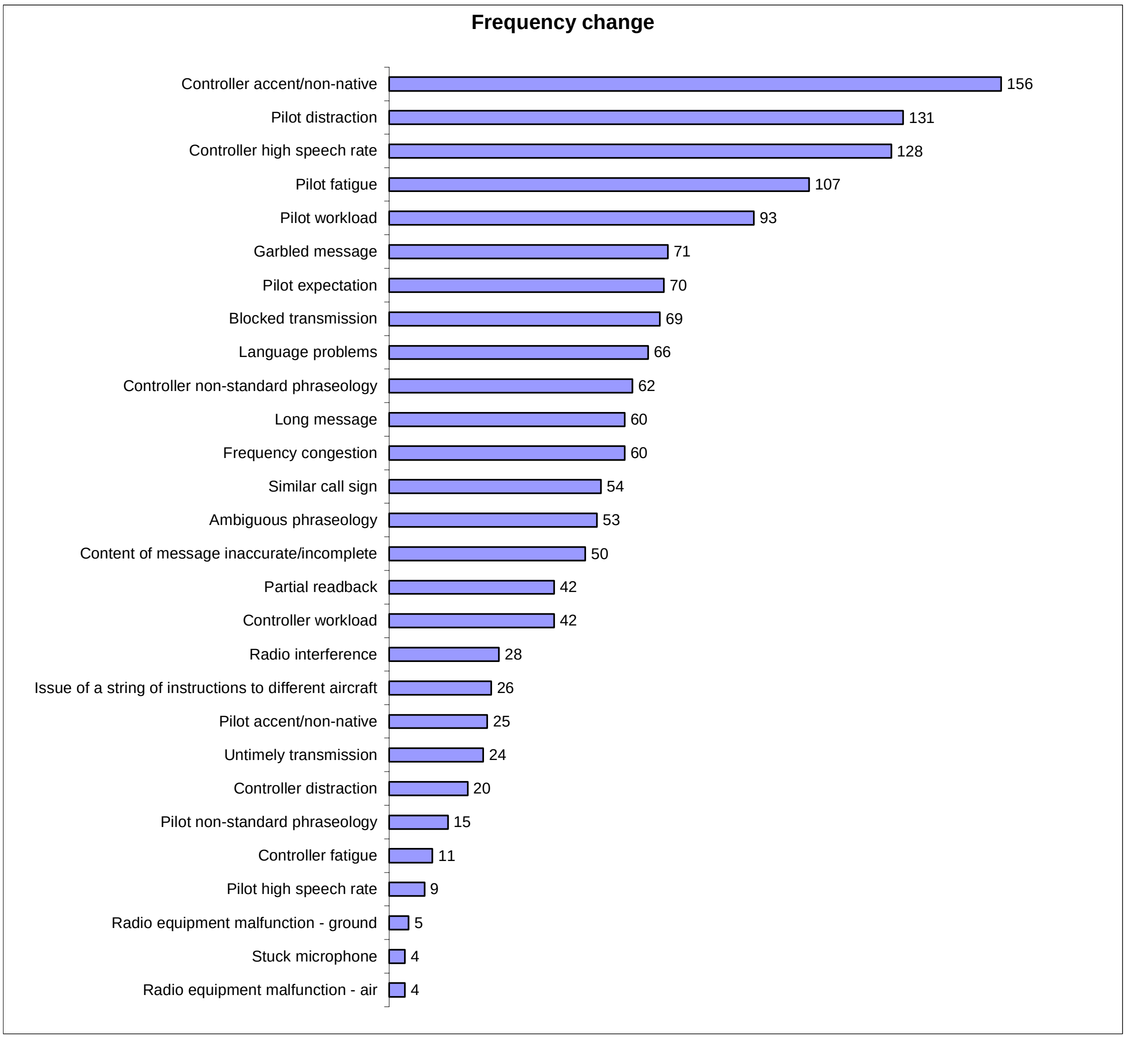

Figure 29: Factors in communication problems involving frequency change cited by pilots and controllers.

4.5.3 Examples of responses from pilots and controllers

> On that particular flight we were operating for [Airline X] the co-pilot during flight missed several calls when I was in the washroom since the calls were given in French and he did not understand any word of it. He expected to receive calls in English. This led to an embarrassing situation later for the controller and to today I do not understand why French pilots as well as controllers use French for ATC since they both KNOW English.
>
> [Pilot 155]

Frequencies have become too long i.e. 121.765. There is much room for error. A solution would be to omit the decimal/point quotation i.e. 121765. Also a mix-up of digits happens due to poor quality of modern radios since the old (wider) frequency gaps did not give as much distortion of speech as the narrow bandwidth. A solution would be to use combined digits in speech i.e. one twenty-one seven sixty-five (once again omit decimal/point).

[Pilot 195]

Controllers could slow down the rate at which they read out the next frequency and not add it to the end of a long instruction. The six digit frequencies are less easy to read back than the old five digit frequencies especially if they are read out quickly.
[Pilot 326]

Digits should be pronounced more like the ICAO standards. The difference between 2 and 3 is sometimes hardly readable (even in GB). Sometimes a read back on what I seem to have heard gives no reply while at a later stage (after switching back) the same ATC controller gives a new frequency where one digit is added. This occurs mostly when channels are involved. A frequency input panel, where you can type the digits while listening could change this problem because in my view it's a mix of the pilots capacity to remember a lot of numerical items like a heading change, altitude change and to report this information on a given frequency. Advice 1: Limit the number of instructions per call or slow down the speech rate. Pilots can make notes. Advice 2: Change the frequency system to a system they use in the military (e.g. "switch to channel 137"). Those are short maximal 4 digits messages. Advice 3: Instead of turning knobs use numeric pushbuttons to select the next frequency. Combined with some smart logic to remember the frequency (channel) which you were using before (cancelling one or two misdial attempt) a good performance.

[Pilot 176]

4.5.4 Summary of recommendations by pilots and controllers

The recommendations from the survey participants can be summarised and classified in R/T skill, frequency assignment and technology.

R/T skill

Many pilots and controllers believe that improvement of R/T skill and discipline will help to reduce the problems with frequency changes. The following list will improve the quality of communication according to the survey respondents:

Recommendations for pilots:

- Use standard phraseology.
- Use English language only.
- Keep the last/previous frequency available on the standby panel.
- Check in promptly on the new frequency.
- Keep the mike in hand as long as no change in frequency has yet taken place.
- Write the new frequency down.
- Readback and allow time for correction by the air traffic controller before switching over to the new frequency.

Recommendations for air traffic controllers:

- Issue a frequency change as a single instruction. A frequency change is often wrong when it is part of a long message. Therefore, the air traffic controllers should issue a frequency change with only one other instruction.
- Communication should be short and include concise instructions.
- Speak slowly, in a steady rate and clearly. Carefully pronounce numbers (especially the numbers ‘2’ and ‘3’ sound similar in R/T).
- Give frequency change in time (before crew is out of reach).
- Pay attention to the pilot’s readback and confirm the correct frequency.

Frequency assignment

Survey participants provided suggestions to change the way frequencies are defined and assigned:

- Use channels. Instead of using frequencies in six digits, channels can be introduced, which means that pilots would have to select for instance channel 5 instead of 125.450.
- Reduce the frequency length. A reduction of the number of digits in the frequency makes it easier for pilots to remember the frequency. Especially with the introduction of six digits frequencies, in combination with four digit call-signs, instructions on speed, altitude, heading, QNH etc, there is great potential for making errors. All frequencies start with a “1”, so the frequencies can be shortened by leaving out the “1” and omitting the decimal quotation. Another improvement could be the use of combined digits in speech: one twenty-one seven sixty-five in stead of 121.765. (This was also recommended in the context of call-sign confusion).
- Integrate frequencies to be expected on the flight plan or a navigation chart, so that pilots know when approximately to expect a frequency change and to which frequency.
- Reduce the number of frequency changes necessary, by expanding sectors or increasing the frequency range.

Technology

Recommendations by survey participants related to technology include:

- Reduction of frequency changes by a combination of actions like extending the coverage of transmitters/receivers and a reduction of air traffic control sectors.
- Introduction of a numeric keypad instead of knob for selecting the frequency in the cockpit.
- Use of data link.
- Use of noise reduction headsets.
- Automatic switch over to new frequency.

4.6 Response from pilots and controllers on non-standard phraseology

4.6.1 General

About half of the population of survey respondents (160, 47%) commented on the problem of non-standard phraseology. In the suggestions related to this topic many pilots have noted their experiences in the United States of America, South America, Africa and the Far East (the majority of the pilots participating in the survey flew long-haul routes). With respect to the situation in Europe pilots remark that most problems occur in countries like Italy, France, Spain and Greece, where controllers speak also in the local language. Radio communication requires standardisation to prevent mistakes and misunderstandings. Most recommendations mentioned in the survey are therefore in the field of R/T communication skills and practise, like better radio discipline, stick to standard phraseology, better training, use a single language only (English). Many survey respondents underline the importance of standard phraseology, which requires discipline and effort from both flight crews and air traffic controllers.

4.6.2 Subjective frequency estimation and causal factors

Figure 30 shows the estimation by pilots and controllers of the frequency with which they experience a communication occurrence involving non-standard phraseology. More than half of the group of participants report that they experience non-standard phraseology on a weekly basis.

In the survey questionnaire the participants could assign contributing factors to the occurrences of this type of communication problem. Figure 31 shows the frequency of factors that contributed to this type of communication problem, according to pilots and controllers. The figure shows that the top five factors contributing to the occurrences involving non-standard phraseology are:

- Controller non-standard phraseology (64% [15]),
- Controller accent/non-native (49%),
- Language problems (46%),
- Ambiguous phraseology (45%), and
- Pilot non-standard phraseology (41%).

[15] The percentage refers to the number of respondents citing the factor divided by the total number of respondents who experienced a communication problem with non-standard phraseology.

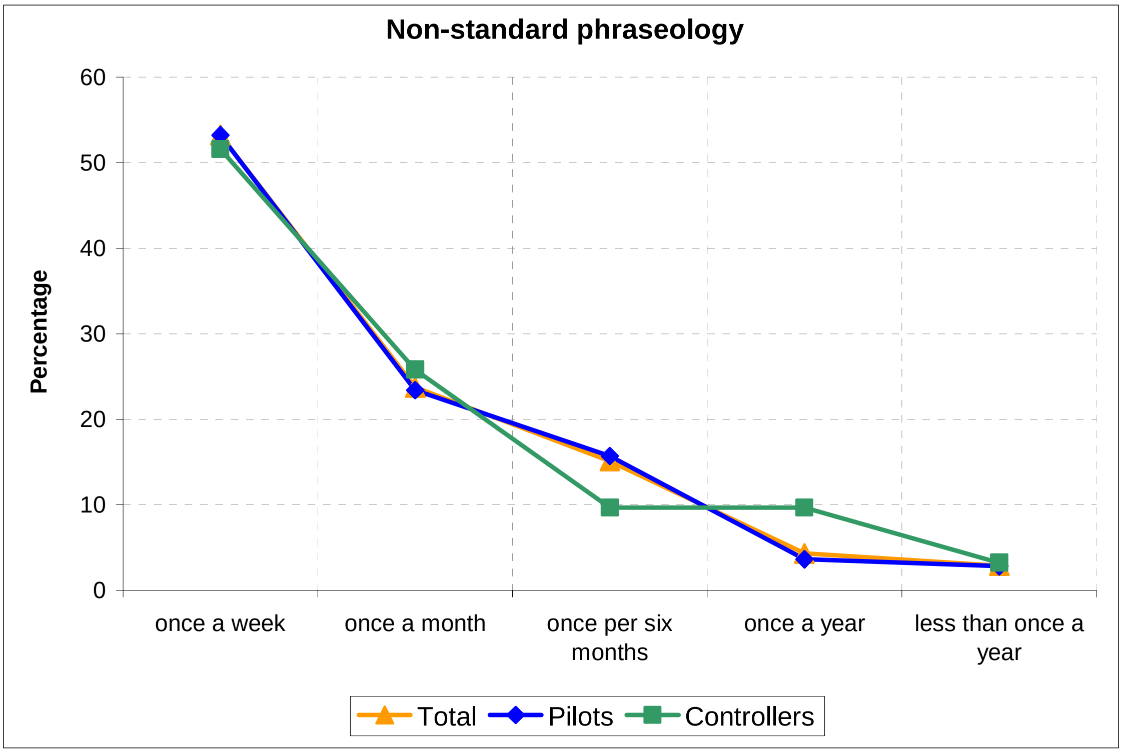

Figure 30: Frequency of communication problems with non-standard phraseology estimated by pilots and controllers.

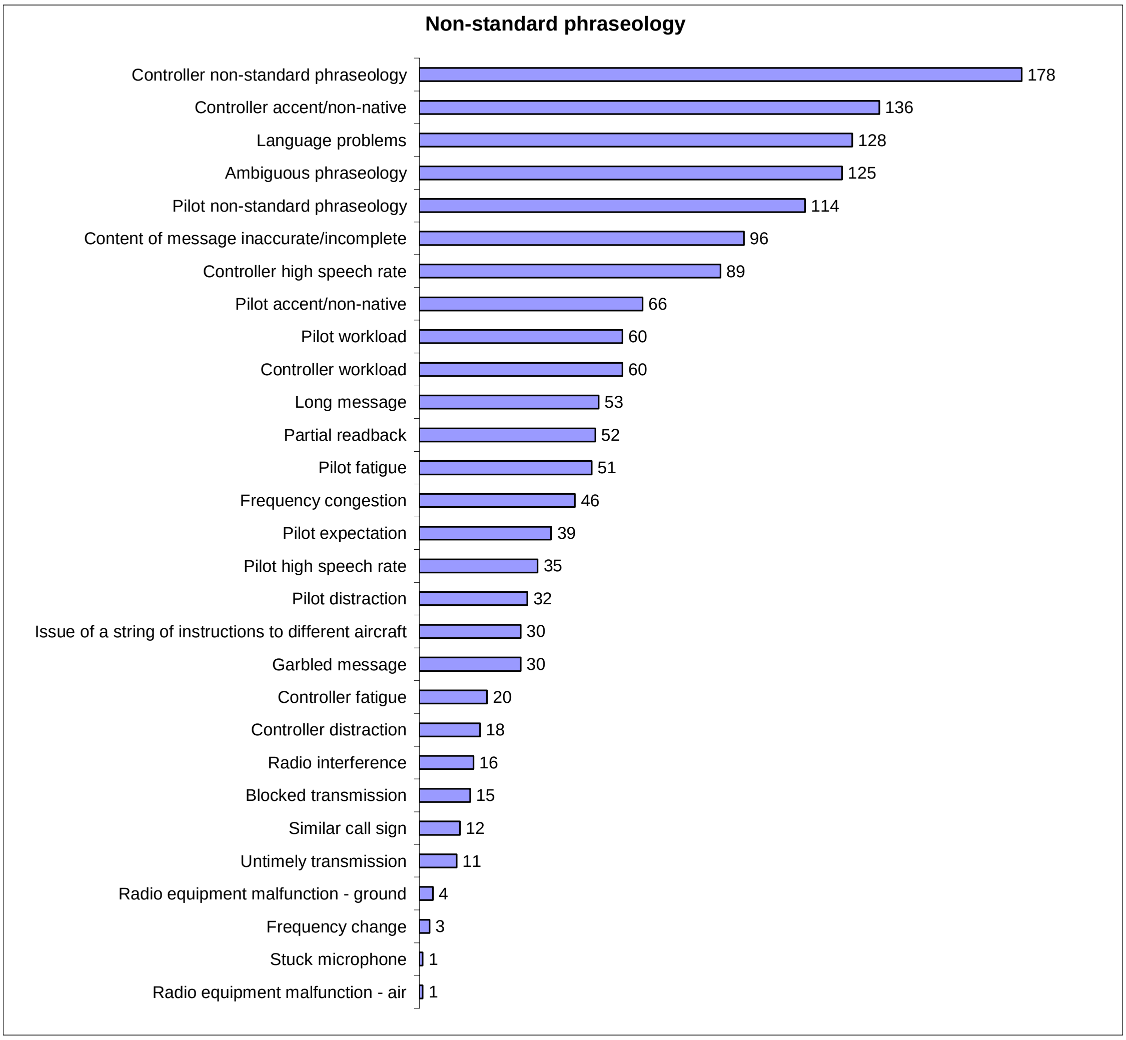

Figure 31: Factors in communication problems involving non-standard phraseology cited by survey participants.

4.6.3 Examples of responses from pilots and controllers

All transmissions have to be done in English, using standard phraseology.
[Pilot 301]

As we get refreshers for almost everything, why not have a refresher about standard phraseology?
[Pilot 88]

> Make sure that phraseology is one of the factors both pilots and controllers must review at least once a year in order to maintain certification; the use of non standard phraseology has been the cause of too many flight incidents.
> [Air traffic controller 147]

> Reduced speech rate of the controller in a high workload environment improves the quality and speed of communication. Less missed calls so less repetition of instructions. On the pilot side, saying "goodbye" or "have a nice day" is very kind but very unwanted in a busy communication environment. Also strict adherence to standard communication rules can be emphasized in for instance Route Manuals.
>
> [Pilot 226]

> Always challenge, if in the slightest doubt about the content. If the message is not logical, confirm.
> [Pilot 184]

> Especially in the southern European regions controllers sometimes don't use standard phraseology. This often leads to unnecessary radio communications to clarify clearances especially for approaches/departures.
> [Pilot 156]

4.6.4 Summary of recommendations by pilots and controllers

The recommendations proposed by the pilots and controllers in the survey are summarised and grouped below in the categories R/T skill, training, language, speech rate and message length.

R/T skills

Recommendations for pilots:

- Use standard phraseology.
- Use English only.
- If in doubt about an instruction, ask for clarification.
- Always readback.

Recommendations for air traffic controllers:

- Use standard phraseology.
- Use English only.
- Speak slowly, clearly, and in a steady rate.
- Always hearback.
- Keep instructions short and simple.

Training

The use of standard phraseology, or R/T in general, could be part of the recurrent training and examination for both pilots and controllers in order to maintain certification.

Language

A common recommendation in the survey deals with the use of native languages in aviation communication. The survey shows that many participants are of the opinion that in aviation communication English should be the only language. A group of respondents remarked that at international airports the use of local languages should be banned. The consequence of a mix of languages on the same radio frequency is that the flight crews who do not understand the native language have a decreased situational awareness. Secondly, the use of native language also contributes to blocked transmissions, since flight crews have difficulty to judge when communication has ended in a foreign language and may unintentionally interrupt a message. It is further recommended by the pilot respondents that the English language skills of controllers should be improved by, for example, mandatory English language classes or examination before the air traffic controller's training begins. (The same argument could also be presented for airline pilots).

Speech rate

A slower speech rate would improve the quality and speed of communication. According to one participant speaking slower has potentially a better effect on communication than speaking fast and having to repeat the instructions.

Message length

The communication should be concise and clear of unnecessary comments. One survey participant stated that usually the use of non-standard phraseology increases with the message length. In addition, niceties such as saying "good day" are nice but at the same time increase the R/T load.

4.7 Response from pilots and controllers on blocked transmission

4.7.1 General

In the survey 152 participants offered suggestions to avoid blocked transmissions. This type of communication problem is always a potential problem in R/T communication, especially in busy sectors. Transmissions by two aircraft or an aircraft and ATC at the same time results in a blocked transmission, i.e. one or both transmissions will be blocked and not heard. Other factors are a stuck microphone or holding the mike switch too long after finishing the message. Some survey respondents remarked that blocked transmissions are the result of ‘bad manners’ instead of procedures. They believe that one should listen out on the new frequency before transmitting rather than start transmitting as soon as the frequency is changed. Different languages on the same frequency are a common problem in blocked transmissions. The use of local languages leads to non-native pilots in particular not being able to judge when a transmission has ended, and therefore transmitting in an untimely manner.

4.7.2 Subjective frequency estimation and causal factors

Figure 32 shows the estimation by pilots and controllers of frequency with which they experience a communication occurrence involving a blocked transmission. The present study observes a significant difference in exposure of pilots and controllers to this type of communication problem. Whereas about 60% of the pilots report that they encounter ‘blocked transmission’ once a week, only 20% of the controllers say they encounter this problem weekly. The majority of the air traffic controllers (40%) encounter this problem once per six months.

In the survey questionnaire the participants could assign contributing factors to the occurrences of this type of communication problem. The frequency of factors that contributed to this type of communication problem according to the pilots and controllers is shown in Figure 33. The five main contributing factors according to the pilots and controllers are:

- Frequency congestion (63% [16])
- Controller workload (33%)
- Untimely transmission (27%)
- Pilot workload (22%)
- Long message (20%)

[16] The percentage refers to the number of respondents citing the factor divided by the total number of respondents who experienced a communication problem with a blocked transmission.

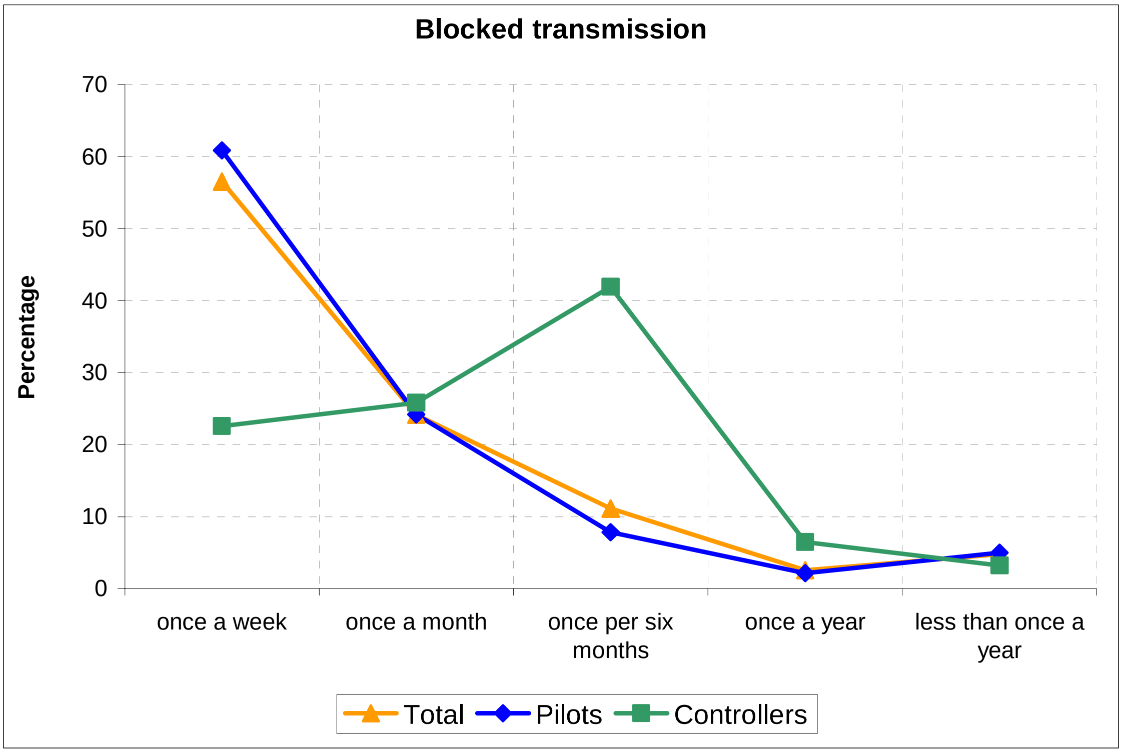

Figure 32: Frequency of communication problems with blocked transmission estimated by pilots and controllers.

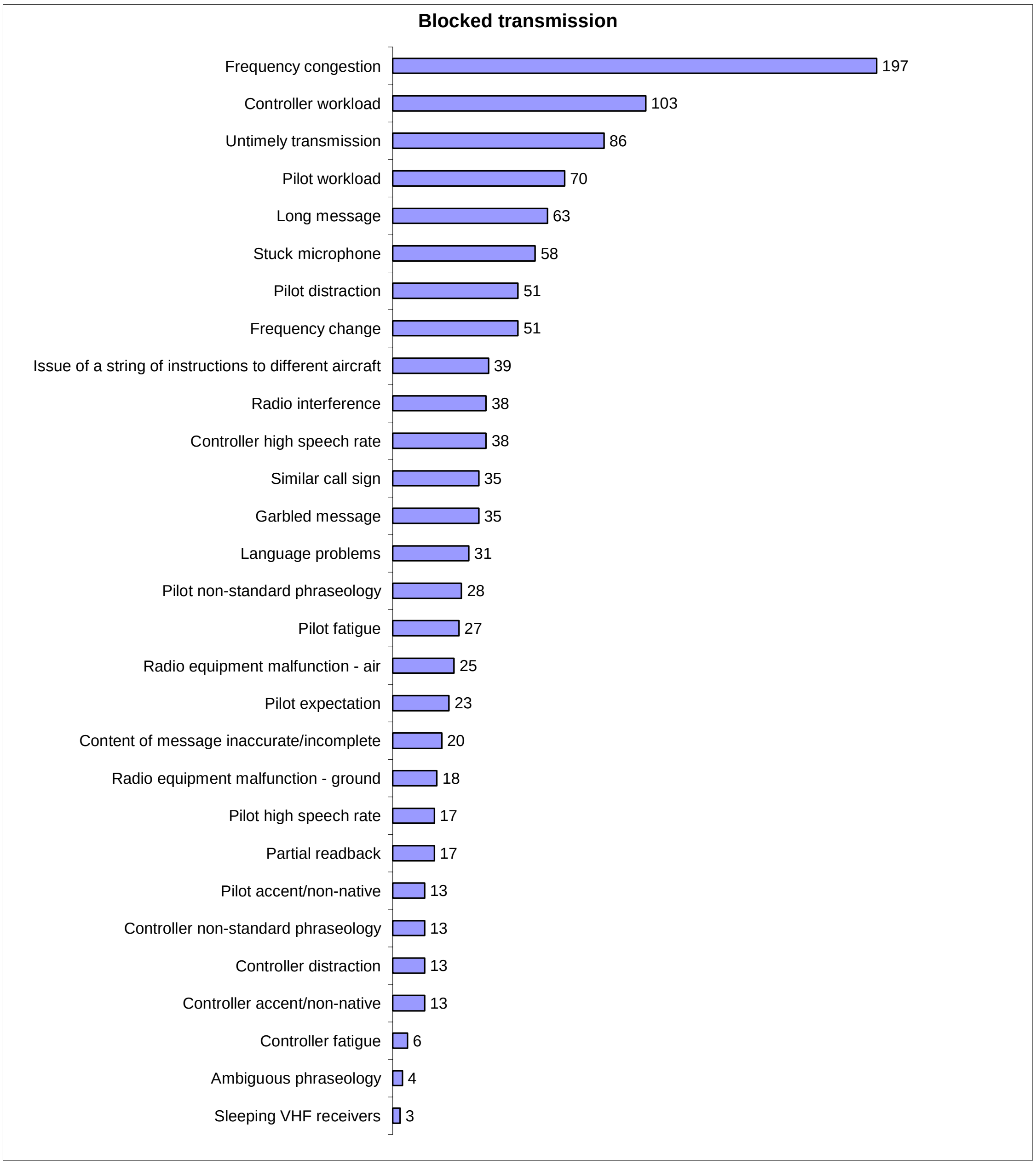

Figure 33: Factors in communication problems involving blocked transmission cited by pilots and controllers.

4.7.3 Examples of responses from pilots and controllers

The main reason for this is when frequencies are busy everyone is trying to get in their check-in call. When a lot of blocked transmissions are happening my feeling is that the controllers are being asked to control too many aircraft. The only short-term solution is more controllers. Long-term we have to work to cut out unnecessary transmission. For example when transferred to a new frequency it should be possible in the future for an aircraft to send a data link message to the ground station which lets the controller know it is now on that frequency. This would eliminate the need to verbally check-in.

[Pilot 25]

When using a native language you never know when to transmit your message because you don't understand the conversation between controller and aircraft leading to a blocked transmission.
[Pilot 297]

Listen to the frequency before talking.
[Air traffic controller 335]

Training: Stress the importance of listening in on the frequency before transmitting. ATC: Strict use of English language as otherwise other aircraft will be unable to determine when communication between ATC facility and a specific aircraft is terminated for the time.
[Pilot 121]

Do not sit on the hand mike.
[Pilot 178]

Improvement can come from a good habit from the USA: always say "blocked" after you hear a blocked transmission so the controller knows he has been blocked and can repeat his message.
[Pilot 198]]

Different languages on the same frequency are a common problem in blocked transmissions. The use of local languages leads to pilots in particular not being able to judge when a transmission has ended, and therefore transmitting in an untimely manner.
[Pilot 15]

Aircraft feature such as RADIO TRANSMIT message on EICAS (e.g. B777) indicating prolonged and possibly unwanted radio transmission.

[Pilot 121]

4.7.4 Summary of recommendations by pilots and controllers

The survey participants offered many different suggestions to avoid or to deal with this type of communication problem. Their recommendations have been grouped into R/T skills and technology.

R/T skills

Recommendations for pilots:

- Always use standard phraseology.
- Listen in on the new frequency before transmitting.
- Call 'blocked' when you detect a blocked transmission.
- Check your microphone; be aware of a stuck microphone.
- Strict use of English language as otherwise other aircraft will be unable to determine when communication between the ATC facility and a specific aircraft is terminated.

Recommendations for air traffic controllers:

- Always use standard phraseology.
- Use short and concise messages.
- Strict use of English language as otherwise other aircraft will be unable to determine when communication between the ATC facility and a specific aircraft is terminated.
- Controllers should not talk continuously but give pilots the opportunity to check in on the frequency by building in rest blocks.
- Reduce the number of aircraft on a frequency or extend the number of controllers, so that the workload per frequency is lower.

Technology

- Blocked transmissions can be partly overcome by anti-blocking devices.
- Design a warning if the mike is pressed too long, for instance by a beep indicting the microphone is still transmitting. (Some aircraft already have such a feature).

4.8 Response from pilots and controllers on radio interference

4.8.1 General

Experiences and suggestions concerning radio interference were brought up by 88 (26%) survey participants. The survey indicates that pilots seldom experience this type of communication problem in Europe. Reportedly, this type of communication problem is mainly encountered in the Far East, Russia, China and sometimes southern Europe (Italy and Greece). Radio interference occurrences often take place in the same area, due to the fixed location of radio stations. The general opinion is that radio inference is more a nuisance than a real danger to flight operations. The general feeling among pilots is that they can not do a lot to solve radio interference problems. When it happens, it is a nuisance, which can be overcome by switching to a new frequency.

4.8.2 Subjective frequency estimation and causal factors

Figure 34 shows the estimation by pilots and controllers of the frequency with which they experience a communication occurrence involving radio interference. About 35% of the participants encounter radio interference problems once per half year. Figure 34 reveals that pilots and controllers encounter this communication problem with a similar frequency, which is not surprising since pilots would normally report radio interference to the air traffic controller and ask for another frequency.
The survey revealed that many radio interference occurrences take place en-route to the Middle and Far East over the less developed regions. The fact that many participants indicated that they had encountered radio interference should be considered in relation to their exposure and destinations (routes). Survey participants commented that in general most radio interference encounters in Europe occur over southern Europe.

In the survey questionnaire the participants could assign contributing factors to the 'radio interference' occurrences. Figure 35 shows the frequency of factors that contributed to this type of communication problem according to pilots and controllers. The most common factor with respect to this type of communication problem is 'radio equipment malfunction (ground)'. The most common factor with respect to this type of communication problem is 'radio equipment malfunction (ground)'. The top five contributing factors according to pilots and controllers are:

- Radio equipment malfunction - ground (23% [17])
- Frequency congestion (9%)
- Radio equipment malfunction - air (9%)
- Blocked transmission (9%)
- Stuck microphone (8%)

[17] The percentage refers to the number of respondents citing the factor divided by the total number of respondents who experienced a communication problem with radio interference.

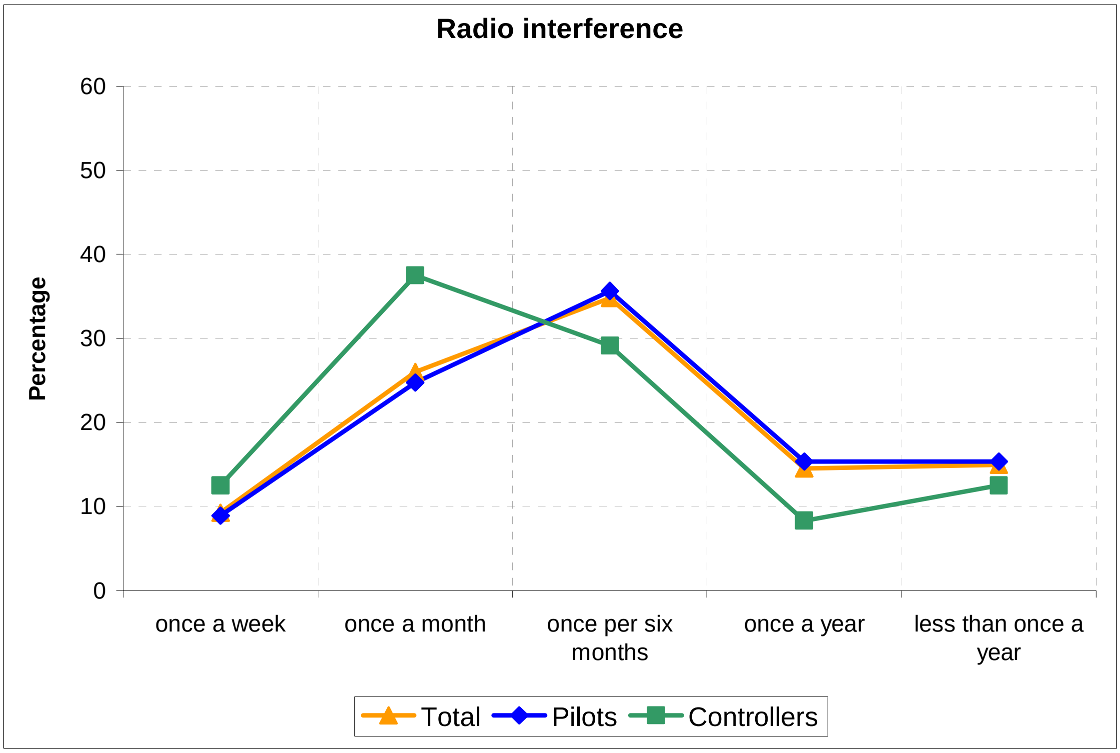

Figure 34: Frequency of communication problems with radio interference estimated by pilots and controllers.

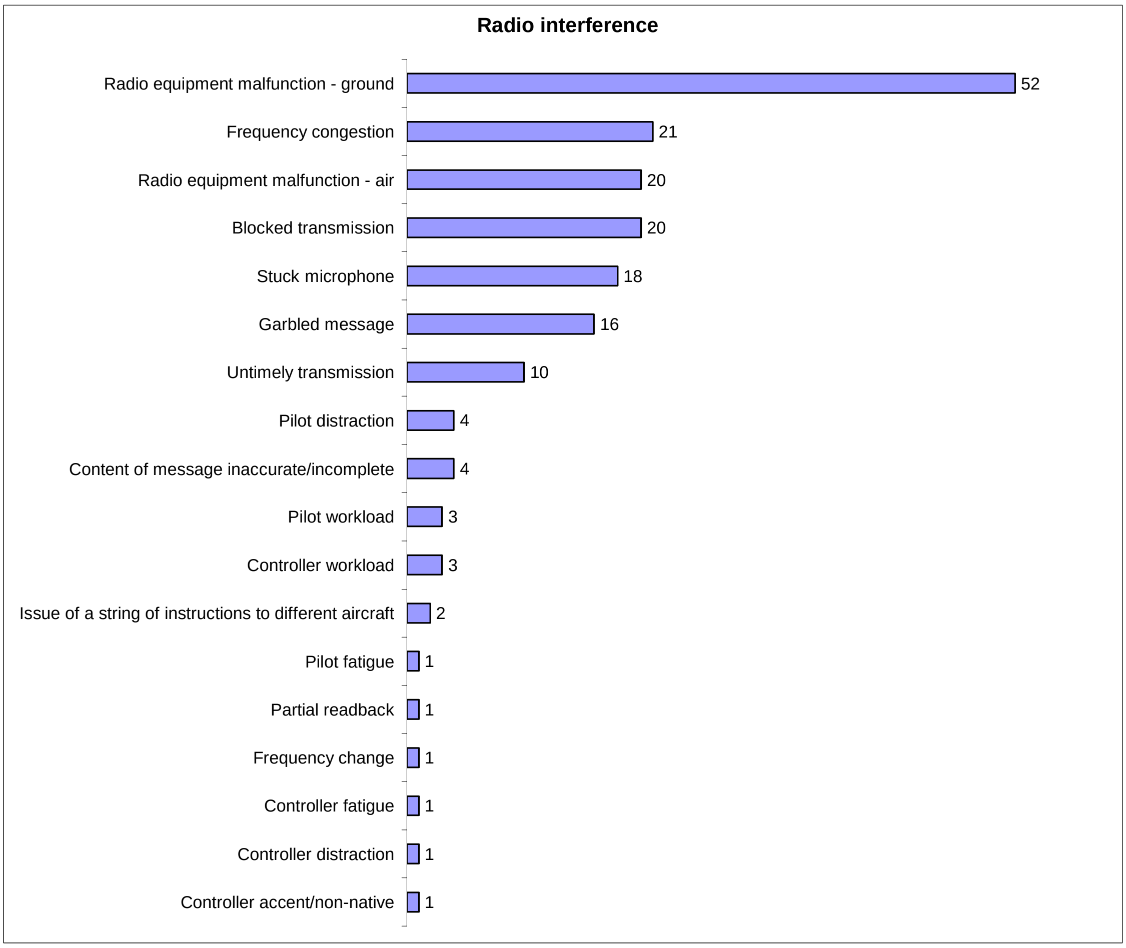

Figure 35: Factors in communication problems involving radio interference cited by pilots and controllers.

4.8.3 Examples of responses from pilots and controllers

> Ask for frequency change and report the occurrence.
> [Pilot 102]

> This issue is probably way out of my possibilities to change anything about that, except for exact reporting on e.g. position, altitude and duration of interference to the respective ATC sectors.
> [Pilot 88]

> We have constant problems with pirate radio stations. The only solution is to have spare frequencies. It seems that the authorities cannot do a lot to solve this problem.
> [Air traffic controller 133]

Keep standby frequency on and be ready to report the malfunction as soon as possible. Call the person responsible to input the frequency change in the ATIS as soon as possible. Inform other sectors of the change of frequency.
[Air traffic controller 11]

4.8.4 Summary of recommendations by pilots and controllers

In summary, the survey participants recommend the following in the area of R/T, technology and regulations:

R/T
Recommendations for pilots:

- Flight crews should report radio interference as soon as possible to the air traffic controller and switch over to another frequency.
- NOTAMs should report areas of potential radio interference and provide back-up frequencies in case radio interference is encountered.

Technology

- Protect all aviation frequencies against radio interference.
- Use other means of communication, like data link in stead of HF frequency.

Regulations
Recommendations for the regulator

- Local governments should take action against radio-pirates and ensure that unauthorised transmissions on ATC frequencies are banned.

4.9 Concluding remarks by pilots and controllers

The survey respondents were given the opportunity to submit general remarks pertaining to the communication safety problems. In total 127 participants offered additional comments, which have been summarised below.

No use of native language besides English in communication

35% of the remarks included a complaint about the use of native language in aviation communication, especially in the countries in Southern Europe. Pilots believe that the use of a single language will help to improve their situational awareness and avoid other communication problems like blocked transmissions. The following quote is a typical example of a suggestion to use only one single language (English) in communication:

> One of the most disturbing issues in air to ground communication is the use of non English in transmissions. This prevents the pilot of composing a clear mental picture of the traffic situation. Also it makes it more difficult not to block out others, because you don't understand when another aircraft has finished transmitting. This use of native languages most frequently occurs in France and Spain. A little less, but still too much, it occurs in Italy and Greece. The rest of Europe, including the eastern European countries, uses standard aviation English most of the time. Next to that, I think, use of standard RT must be emphasised more with pilots. For the controllers, checking of correct readback of clearances is of utmost importance.
> [Pilot 228]

Technology improvements

24% of the general remarks concerned the improvement of communication technology in many different areas. Some participants suggest improving headsets (nose reduction headset). Others say the ground equipment should be improved. Many pilots believe that the introduction of data link will remove a lot of problems related to voice communication. Simple messages such as QNH, frequency changes and standard clearances could be sent to the crew via data link, while the voice communication would only be used for special circumstances. Another recommendation that was proposed in the survey was the use of a numeric keypad instead of turning knob for frequency tuning, which will help to reduce the number of incorrect frequency settings and reduce the time needed to select a frequency according to some pilots.

> Generally I would say that the kind of communication how it is done today fits an air traffic situation with less aircraft than we have in our airspace today. We are using a type of communication that has not changed for about 100 years. There should be thoughts about a different way for air traffic control. For example to get all the instructions via data link and the pilot has to confirm it and the air traffic communication like we have it today is just used maybe in some special cases.
>
> [pilot 28]

Let's move forward with some form of data link as soon as possible to remove routine radio transmissions. I think this is the key to a lot of the above issues.

[Pilot 25]

Written messages would be an enormous improvement in air to ground communications. Above 10.000 feet this should be the only way of communication, below 10.000 feet only the standard messages (cleared to land etc), otherwise (for quick response) the spoken method is preferred.
[Pilot 294]

Routine messages, especially those that are not time critical, should be exchanged by data link (CPDLC).
[Pilot 111]

I think it boils down to introducing more modern communication methods into our world. If you can send an SMS message for a few cents we in our world should be able to get rid of routine communication at cruising level via controller-pilot data link, with monitoring of a frequency for quick intervention or verbal confirmation, i.e. a message is sent to us in the cockpit, and we confirm receipt of a message string via a frequency (i.e. KLM 234 message 146 received), as a backup to our data link side of the business.
[Pilot 257]

Speech rate

The issue of speech rate is addressed in 6% of the remarks by the participants. In general, speaking slowly helps to understand the instructions better and may reduce the need to ask to repeat the instruction. Examples of quotes from the survey with respect to speech rate:

The worst situations in my opinion are caused by two things:

1. The use of HF is not from this world anymore. If we on earth can direct a vehicle on Mars to sniff at the right stone, I'm sure we can figure out some sort of satcom in stead of HF.
2. Controllers that have a heavy accent in their English cannot help this; however, they should not compensate this by speaking faster. As if they want to prove how fluent their English really is. They should speak slower than average instead.

[Pilot 253]

Discard HF communication. My passengers can talk to anybody in the world, while I am shouting to Kabul and Mumbai Radio. This is insane.
[Pilot 178]

It's not cool to talk fast
[Pilot 146]

Contents of communication

A few participants (10) suggested reducing the amount information in the voice communication. They question whether all voice communication, i.e. ATC message contents, is really required and whether some messages could be better passed to the crew via data link for example or be left out entirely. The idea is to limit the voice communication to the essential information that has to be transmitted between pilots and controllers.

Reduction of the message contents (shorter messages) and the use of standard phraseology may help to reduce miscommunication (misunderstanding) and frequency congestion, which may be partly due to a high speech rate and the consequential need to repeat instructions according to some pilots.

> […] Do not give a string of commands as a controller. Last but not least: talk slowly and articulate. It is faster (no say-again) and it makes the environment in which you fly feel less stressed of panicky. It also radiates confidence by the ATC controller and the pilot.
> [Pilot 277]

> In my opinion most problems are directly related to frequency congestion. I have seen a dramatic increase over my 18 years of service. At the same time lengthier message are sometimes used than in the past. E.g. four digit call-signs instead of 2 or 3. And sometimes far too long messages by local regulations. E.g. in the UK one is often supposed to state aircraft type, SID flown, altitude passing, altitude cleared to etc. In my opinion now congestion is becoming more and more a fact of life; regulations should require messages to be short and unambiguous.
> [Pilot 174]

> [..] They usually give in first communication a full report with all the flight plan information and current position, squawk. It's far more information than we need because we already have that information. We would appreciate that they shorten their reports (call-sign, position, altitude and intentions is all we need) so that we can use those valuable seconds for communicating with other aircraft.
> [Controller 337]

Training

> I would recommend a clear standard R/T instruction booklet to be handed out to all pilots, and I would also greatly value recurrent training in this respect once every 3-4 years for both pilots as well as controllers.
> [Pilot 308]

Chapter 5
Discussion of the results

5.1 General

The results of the analysis of the air-ground communication occurrences will be compared in section 5.2 to the results found in the previous study on this subject [Ref. 1]. The section is organised in line with the analysed types of communication problems. The results of the survey of pilots and controllers will be discussed in section 5.3. Furthermore, the results from the occurrence reporting camping will be compared to the results from the survey responses by pilots and controllers in section 5.4.

5.2 Discussion of the results of the occurrence reporting campaign

5.2.1 Overall occurrence data sample

The overall data sample of air-ground communication occurrences contains 535 occurrences that took place in Europe between March 2004 and April 2005. The data was collected by means of an occurrence reporting campaign in which European airlines and Air Navigation Service Providers participated. The data sample is considered to be representative for the situation in Europe.

This study finds that loss of communication is the most common category of reported communication problems in the overall data sample (26%). It is noted that the present study contains slightly more occurrences involving loss of communication and less occurrences concerning readback/hearback error and communication equipment problems in comparison to the previous study. The category ‘other communication problem’ covers occurrences that do not belong into one of the other categories or could not be classified due to a lack of information. 194 of the 535 reported occurrences (36%) come under this category and involve to a large extent similar call-sign confusion (89 of 194; 46%).

Both studies show similar results with respect to the consequences of communication problems, although the actual percentages differ. The present study points out that many occurrences have no consequence at all (36%) or result in prolonged loss of communication (23%). [Ref. 1] found prolonged loss of communication as the most common consequence (31%), followed by ‘no consequence’ (21%). In the current data sample there are a number of occurrences which deal with pilots reporting similar call-signs out of concern, without having encountered a real problem and thus reporting ‘no consequence’. Similar call-sign was reported as a factor in 55% of the occurrences with consequence ‘none’. This may explain the relatively high percentage of ‘no consequence’ occurrences in the current data sample.

The present study confirms the results of [Ref. 1] regarding the distribution of occurrences over the flight phases: most occurrences happen in cruise flight (41%), while almost a third of the occurrences take place in the vicinity of the airport (31%).

The most common contributing factors found in this study are similar call-signs (33% of the occurrences), frequency change (12%) and airborne radio equipment malfunction (8%). [Ref. 1] presents comparable results with similar call-sign as most common factor, followed by sleeping VHF receivers and frequency change. In the current study, sleeping VHF receivers were reported as contributing factor in only 4% of the occurrences (12% in [Ref. 1]). An explanation for this difference could be either that relatively less occurrences with sleeping VHF receivers occurred due to actions taken to change the software on radios suspected of having this problem, or that events that might previously have been categorised as being due to a sleeping receiver are now classified as a radio equipment malfunction. This would explain why the current study finds ‘radio equipment malfunction – air’ relatively more often reported (8%) than in [Ref. 1] (4%).

5.2.2 Loss of communication

It was observed in the current study that most loss of communication occurrences happen in the cruise (73%). This is a larger portion than found by [Ref. 1] (53%), but it is believed to be more representative because of the larger data set used in the current study. The contributing factors that were most often cited in this type of communication problem are: frequency change (35%), sleeping VHF receivers (15%) and airborne radio equipment malfunction (12%).

There was not enough information available in many occurrence reports to allow a statistically reliable more detailed analysis on the causes of this type of communication problem.

Analysis of the occurrences with a frequency change as contributing factor reveals that these occurrences are mainly caused by the flight crew tuning in the wrong radio frequency or the air traffic controller forgetting to hand-over the aircraft in time to the new frequency. The occurrences classified as sleeping VHF receivers or airborne radio equipment malfunctions are in a few cases the result of a failure of the radio equipment or a speaker/radio volume that is selected too low or off, while the crew does not use the headsets.

[Ref. 1] found radio interference as the most common contributing factor in loss of communication. Yet, that observation is not confirmed in the current analysis, which yields that radio interference is reportedly a factor in only 1% of the occurrences involving loss of communication.

5.2.3 Readback/hearback errors

The current study finds that a similar call-sign is a factor in 37% of the occurrences, followed by pilot expectation and frequency change in respectively 17% and 15% of the occurrences. [Ref. 1] also found similar call-sign as the main factor in this type of communication problem. The present study reveals that a large portion of the readback/hearback problems results in an altitude deviation (37%) or an aircraft accepting an instruction meant for another aircraft (31%).

5.2.4 Communication equipment problem

The present study finds that communication equipment problems are to a large extent caused by the factors ‘radio equipment malfunction – air’ and ‘radio equipment malfunction – ground’, which is not surprising given the type of problem. What is remarkable, however, is that sleeping VHF receivers were never assigned as a contributing factor in any of the occurrences involving communication equipment problems. This is contrary to the results found by [Ref. 1], where sleeping VHF receivers were cited in the majority of the communication equipment problems. An explanation for this difference could be either that relatively less occurrences with sleeping VHF receivers occurred due to actions taken to change the software on radios suspected of having this problem, or that events that might previously have been categorised as being due to a sleeping receiver are now classified as a radio equipment malfunction. The factor ‘radio equipment malfunction – ground’ was often not further detailed in the occurrence reports. Apparently, reporters do not understand the causes of communication equipment problems. For a better understanding of the root causes most occurrences would need further investigation by specialists, which is outside the scope of this study.

5.2.5 No pilot readback

The data sample of occurrences involving no pilot readback is too small to conduct a meaningful analysis.

5.2.6 Hearback error

The data sample of occurrences involving a hearback error is too small to conduct a meaningful analysis.

5.2.7 Other communication problem

The category 'other communication problem' was meant to classify occurrences, which did not fulfil the definition of one of the foregoing types of communication problems. This study finds that many occurrences in this category concern similar call-signs (46%). Radio interference (13%) and inaccurate message content (9%) are also often cited as factor in this category of communication problems.

5.2.8 Communication problem not reported

In 18% of the reported occurrences in the present data sample the type of communication problem was not reported for unknown reasons. Some information could be derived from the other fields in the reporting form that were filled out in those occurrences. The majority of the occurrences with no reported problem did not have any consequences (60%), while loss of separation (12%), instruction issued to wrong aircraft (10%) and wrong aircraft accepted clearance (8%) were also reported. In 64% of the occurrences in this category a similar call-sign was reported as the contributing factor.
It is concluded that many occurrences in this category deal with similar call-signs with no encountered consequences, which were apparently reported out of concern and to draw attention to the problem (76% of the occurrences in this category involving similar call-signs had no reported consequence). Similar call-signs often lead to misunderstanding and confusion, which causes the controller to issue an instruction to the wrong aircraft or an instruction meant for another aircraft is picked up by an aircraft with a similar call-sign.

5.3 Discussion of the results of the survey of pilots and controllers

5.3.1 General

The survey of pilots and controllers provided many lessons learnt, comments and suggestions to avoid communication problems and to improve pilot-controller communication. This is valuable information since it comes from people directly involved in pilot-controller communication. The responses of pilots and controllers in the survey questionnaire give insight in their perspective on air-ground communication problems. One should bear in mind that each individual provided his/her own comments and suggestions, which can be biased by experience and exposure to certain types of communication problems.

The sleeping VHF receiver problem is an issue that may have been misunderstood, unrecognized or considered as a different type of communication problem by the survey respondents considering their comments and suggestions on this topic. Their feedback on sleeping VHF receivers should thus be interpreted with care. Nevertheless, the results of the survey on sleeping VHF receivers are included in the report since the suggestions are mostly related to loss of contact, which is valuable information.

The current study presents an overview of the recommendations by the pilots and controllers in Chapter 4. The entire set of comments and suggestions was analysed to get a good overview, but the conclusions and recommendations have been limited to the European situation, since the survey was intended to address communication problems in Europe. This section will discuss the recommendations on a high level. Some recommendations require a further safety study to examine the feasibility in terms of operational impact, (communication) safety consequences, costs, timeline for implementation, and possible side effects. Such safety assessments are beyond the scope of the present study.

5.3.2 Survey participants

The composition of the group of survey participants has to be taken into account when drawing conclusions from the survey. The group of pilots and controllers are considered to be representative, based on their working experience and background. The group of pilots consists largely of pilots who operate on long-haul flights, which shows in their comments related to ATC communication outside Europe. Generally speaking, long- and short-haul pilots make the same amount of flying hours yearly, although short-haul pilots conduct more take-offs and landings. Yet, the total exposure to the ATC environment (in terms of communication exchanges) of short- and long-haul pilots is comparable. The air traffic controllers are underrepresented in numbers compared to the group of pilots. However, the value of the recommendations by the air traffic controllers is not affected by their population size in the survey.

5.3.3 Subjective frequency estimation

The types of communication problems that were addressed in the survey include sleeping VHF receivers, similar call-signs, radio interference, blocked transmission, non-standard phraseology, and frequency change problems. Regarding the exposure to these types of communication problems estimated by pilots and controllers, this study shows that similar call-signs, frequency change problems, blocked transmission and non-standard phraseology are encountered on a regular basis, i.e. weekly to monthly. Radio interference and sleeping VHF receivers are less common experienced, i.e. half-yearly to yearly.

5.3.4 Contributing factors of communication problems

According to the pilots and controllers the major contributing factors to the different types of communication problems are related to human factors: controller accent, controller speech rate, controller workload, pilot distraction, pilot workload and pilot fatigue.

5.4 Discussion on recommendations made by pilots and controllers

5.4.1 General

This section will discuss recommendations proposed by pilots and controllers in the survey. The researchers reviewed all suggestions from the survey participants and summarised the most relevant (in terms of merit and feasibility) recommendations. In addition, recommendations requiring further study have been identified. The subsections deal with the recommendations in the area of similar call-signs, frequency change problems, blocked transmissions, R/T skill and discipline, and technology. Recommendations on radio interference and sleeping VHF receivers were limited and do not require further discussion because they are covered by the sections on R/T skill and discipline, and technology.

5.4.2 Similar call-sign

Three recommendations from pilots and controllers are deemed helpful:

- The air traffic controller should inform the flight crew when aircraft operate in the same sector with similar call-signs.
- The air traffic controller and pilots should accentuate important words and syllables in pronunciation of a call-sign, e.g. [company name] five SIX zero.
- Use of alphanumeric call-signs.

Many survey participants question the logic in use to assign call-signs to flights. Today, many airlines assign call-signs based on the destination of the flight (continent, outbound, inbound, city). As a result flights departing for the same general destination (direction) have similar call-signs. The pilots and controllers proposed in the survey to use alphanumeric call-signs and to change the logic used by airlines to establish call-signs for flights and destinations. This recommendation implies that airlines should change the call-sign assignment logic that they use to 'randomise' call-signs instead. Moreover, airlines could coordinate the call-signs with other operators to minimise similar call-signs across different operators. This recommendation will reduce the number of similar call-signs, but will also have an organisational/administrative impact on the airlines. It is recommended to get feedback from operators in this respect. At least airlines could be advised to consider a different call-sign assignment logic.

Similarly, survey participants suggest that ANSPs could systematically analyse call-signs on a daily basis to detect similar call-signs in flight plans and to change them accordingly. This refers to strategic identification of similar call-signs, which certainly is a wise idea, but one that will have drawbacks in terms of the flight plan filling process. It requires a procedure for changing call-signs and rejection of flight plans with similar call-signs, which may cause time delays (and losing a slot). Strategic identification of similar call-signs in the winter/summer flight schedule of an airline at a time when new schedules are prepared could be considered by airlines and ANSPs. 'Strategic' means based on proposed flight schedules and repetitive flight plans of operators or based on pilot/controller reports (information typically available at CFMU). With this information operators may be contacted to investigate the potential to change the call-sign allocation of specific flights

One recommendation in the survey reads: "*Issue temporary call-signs when aircraft operate with similar call-signs in a sector at the same time*". Although this idea seems relatively easy to implement, it should be given more thought. The controller can only assign a temporary call-sign for his/her sector. When the aircraft is handed over to another sector it may lead to confusion about which call-sign the flight should use in the next sector. This practise will require a procedure to hand-over aircraft with a temporary call-sign. In addition, a temporary call-sign may introduce confusion with the crew and controller on the actual call-sign. Pilots could for example decide to change the call-sign in the Flight Management System leading to potential problems in company communication or data logging through ACARS (the flight ID is sometimes used as a specific address). Also, the crew may get confused when they have more temporary (possibly different) call-signs during one flight.

Some participants believe that data link will solve a lot of problems, including call-sign confusion. Introduction of data link through the existing ACARS network has been a common practice for Oceanic Clearances for a number of years. The coming period will see the introduction of Airway Clearance Delivery through data link at several European major airports. Due to technological limitations application of data link clearances is presently limited to clearances that are not time critical. With the arrival of new data link technology (for example VDL Mode 4 transponders) new opportunities for the use of data link will arrive. Surely these technologies will be able to address some of the issues present in voice communications but introduction of data link may also have its drawbacks, such as absence of party-line, dependency on a specific technology and issues related to the human-machine interface. Further study into the possibilities and challenges associated with further introduction of data link technology is required.

5.4.3 Frequency change

As for frequency change problems, many pilots think that since the introduction of the new six digit 8,33 kHz frequencies it is more difficult to remember the frequency. Three useful recommendations from pilots and controllers are the following:

- Issue a frequency change as a single instruction. A frequency change is often wrong when it is part of a long message. Therefore, air traffic controllers should issue a frequency change with only one other instruction.
- Integrate frequencies to be expected on the flight plan or a navigation chart, so that pilots know when approximately to expect a frequency change and to which frequency.
- Use data link in the future to issue frequency change instructions.

One suggestion was to use discrete "channels" instead of frequencies. This recommendation needs further study to assess its potential. It would certainly be a long term project, which will require hardware changes in aircraft, which is costly and time-consuming. In addition, such a change should be implemented world-wide: for instance non-European operators must be able to use channels or the 'old' frequencies and, vice versa, European operators should be able to use the channels outside Europe.

Finally, pilots are recommended to promptly check in on the new frequency. This enables them to check without delay whether they are on the correct frequency. On the other hand, it was suggested that pilots should listen to the new frequency first, before they start talking in order to avoid blocked transmissions. (Sometimes a frequency is so congested that pilots have no choice but to wait for a chance to speak).

5.4.4 Blocked transmission

This type of communication problem is always a potential problem in R/T communication, especially in busy sectors. Transmissions by two aircraft or an aircraft and ATC at the same time results in a blocked transmission, i.e. one of the two or both transmissions will be blocked and not heard. This type of blocked transmissions is often found on busy frequencies where a number of aircraft are awaiting the possibility to check in, but may occur at random times on any frequency. Other factors are a stuck microphone or holding the mike switch too long after finishing the message. Adherence to common use of R/T best practises, such as initiating a transmission only when the previous clearance has been given and read back, may alleviate some of the occurrences of blocked transmission but not all.

Some survey respondents remarked that blocked transmissions are the result of bad manners and recommend that pilots should listen out the new frequency before transmitting rather than start transmitting as soon as the frequency is changed. In their defence, on busy frequencies pilots may feel they do not have the luxury to wait until all other aircraft have finished their business. One solution could be that a hand-over to the next sector may be done with the instruction to monitor only, but other methods may be available.

Different languages on the same frequency are a common problem in blocked transmissions. The use of local languages leads to non-native pilots in particular not being able to judge when a transmission has ended, and therefore transmitting in an untimely manner. The recommendation to use only English as language in aviation radio communication is helpful in this respect. (Secondly, using English only can increase the situation awareness of pilots). However, the drawback is that a portion of the pilots operating in Europe is not fluent in English, which may increase communication problems.

When data link becomes available it will help to avoid blocked transmission. As was remarked before, the use of data link will require procedures and more study is needed to determine what is feasible through data link and what is not.

5.4.5 R/T skill and discipline

This study concludes that the survey participants comprehend that it is important that controllers and pilots have good R/T skills and discipline in order to avoid communication problems. Good R/T skill and discipline are the backbone of pilot-controller communication and attributes to clear communication. Pilots and controllers provide rather obvious recommendations, like always use standard phraseology, speaking slowly and clearly. Although obvious, they are definitely beneficial to clear radio communication and will help to minimise the major communication problems. The most common recommendations from pilots and controllers in this area are:

- Always use standard phraseology.
- Always use a slow and steady speech rate.
- Use a single language in communication, i.e. only English.

These three recommendations are backed up by the data on contributing factors, which were reported by the survey participants as contributing to communication problems. Controller accent, controller speech rate, language problems and non-standard phraseology were often reported by the survey respondents as contributing to communication problems such as frequency change and similar call-signs. Remarkably, the current study reveals that factors related to R/T skills (e.g. phraseology, accent, speech rate) and human factors (e.g. distraction, expectation) hardly show up in the occurrence reports as contributing to the occurrences. It seems that in the day-to-day communication with controllers, pilots experience misunderstanding, confusion and annoyance pertaining to the controllers' accent, speech rate, use of native language, non-standard phraseology etc, and for that reason suggest the above mentioned three recommendations. Apparently, when it comes to reporting communication occurrences other factors are deemed more important than the R/T skills (at least they are not reported). Although factors related to R/T skill and discipline were often not reported in the occurrences, they may have been present. The two main factors found in the overall data sample (similar call-sign and frequency change problems) are namely partly related to R/T skills. For example, the pronunciation and speech rate may be the cause of call-sign confusion.

It was recommended to introduce R/T refresher training in the recurrent training of airline pilots, and for air traffic controllers. This recommendation is appropriate to refresh pilots and controllers in the use of standard phraseology, speech rate and readback/hearback. It needs further study to determine what such a training programme should cover and how it could be incorporated in recurrent training programmes.

5.4.6 Technological improvements

A remark that was often observed in the survey responses deals with the current state of radio communication technology in aviation. It is regarded by some participants as old-fashioned, when looking at the communication technology available in our daily lives and other areas (e.g. space applications). A lot of survey participants are hopeful and optimistic that data link communication between aircraft and ground will help to avoid many voice communication problems. As data link will remove some problems of present-day radio communication, it will certainly introduce a whole new range of safety and operational issues.

5.4.7 Concluding remarks

Recommendations put forward by the survey participants should not be judged at a first glance but need further study to examine their potential. For instance, one recommendation reads '*reduce the number of frequencies to minimise frequency changes*', whereas others say '*increase number of frequencies to reduce frequency congestion, blocked transmissions, and all other associated problems*'. These two opposite recommendations could be beneficial to air-ground communication and simultaneously have negative side effects.
Some recommendations from the survey respondents require a safety study to examine the feasibility in terms of safety and operational consequences and benefits, costs, timeline for implementation and possible side effects. This is necessary before a rational decision can be made whether or not to implement a particular recommendation. Such a safety assessment requires participation from the different actors involved in aviation communication.

5.5 Comparison between the occurrence reports and the survey responses

This section compares the results of the occurrence reporting campaign with the responses provided by airline pilots and controllers in the survey questionnaire. It is noted that factors such as the use of non-standard phraseology, high speech rate, accent, and the use of local languages in radio communication are infrequently reported as contributing factors in the occurrence reports from the reporting campaign. This is remarkable compared to the results from the survey of pilots and controllers. The vast majority of the survey respondents stated y that these factors are a great concern and cause misunderstanding and irritation. Especially pilots stress in their recommendations the importance of standard phraseology, the use of Aviation English only, and a slow and steady speech rate. It is concluded that these factors apparently contribute to communication workload, misunderstanding and irritation, but are not directly cited as contributing factors in occurrence reports. An explanation could be that most occurrence reports were not filed by the pilots themselves but by safety officers on the basis of pilot Air Safety Reports, which may not specifically question whether the above mentioned factors were present in the occurrence. Conversely, the survey questionnaire gave participants a direct opportunity to cite these types of factors (in other words when specifically questioned about these issues, they report them more often than when not questioned).

Chapter 6
Conclusions

6.1 Air-ground communication occurrences

The following conclusions are drawn based on the analysis of the communication occurrences from the occurrence reporting campaign:

- The occurrence reporting campaign that was organised to collect data on air-ground communication safety occurrences from airlines and Air Navigation Service Providers provided a representative data sample reflecting the situation in Europe.

- In total 535 occurrences of communication problems over Europe in the time frame March 2004 until April 2005 were analysed in the present study. The current study shows that the major communication problems are: loss of communication (26%), readback/hearback errors (12%[18]) and communication equipment problems (8%). 36% of the occurrences in the data sample were classified as 'other communication problem'. This category covers occurrences which did not fit into one of the five types of communication problems or which could not be classified due to a lack of information. About half of the occurrences involving an 'other communication problem' refer to similar call-sign confusion. The results of the current study validate the results of the previous study by [van Es, 2004].

[18] This percentage includes occurrences with readback/hearback errors, no pilot readback and hearback errors.

- The present-day air-ground communications depend primarily on voice communication. Many different human and technical factors contribute to communication problems. The two main contributing factors are similar call-signs (33%) and frequency change (12%). Frequency change problems are to a large extent caused by a forgotten hand-over by the controller, and the flight crew tuning in the wrong frequency. Other factors often cited are: airborne radio equipment malfunction, sleeping VHF receivers and radio interference.

- Many reported occurrences had no direct safety consequence (36%). Prolonged loss of communication is the most common consequence of all types of communication problems (23%).

- Air-ground communication safety occurrences are relatively rare compared to the number of air traffic control instructions given daily. Although many communication occurrences result in momentary misunderstanding, confusion or annoyance, these problems can still have a high-risk potential. All communication problems and causes found in this study are not new and have been reported in previous studies.

6.2 Survey of pilots and controllers

The following conclusions have been drawn based on the analysis of the responses and recommendations provided by airline pilots and air traffic controllers in the survey questionnaire:

- The survey of professional airline pilots and air traffic controllers, which was organised in order to collect recommendations on air-ground communication, provided many useful suggestions, comments and lessons learnt regarding the situation in Europe. A representative group of 344 pilots and controllers participated in the survey.

- The majority of the pilots and controllers say they encounter similar call-signs, frequency change, blocked transmission and non-standard phraseology more than once a month. Radio interference and sleeping VHF receivers are infrequently experienced by the participants (in the order of once per half year to once per year).

- According to the survey participants the main factors contributing to the major communication problems such as similar call-sign confusion, frequency change and blocked transmissions are: controller accent, controller speech rate, controller's non-standard phraseology, and pilot distraction, pilot expectation, pilot fatigue and pilot workload.

- Many recommendations suggested by the pilots and controllers to avoid and minimise communication problems are rather obvious but certainly have merit. They are similar to recommendations found in previous studies and come down to adherence to good R/T skill and discipline: the use of standard phraseology, slow speech rate, using short and concise instructions, and a good readback/hearback discipline. It was suggested to introduce recurrent R/T training for pilots and controllers.

- To avoid similar call-signs the survey participants recommend changing the call-sign assignment logic used by operators, the use of alphanumeric call-signs and a systematic analysis of flight plans/schedules to detect similar call-signs. A different pronunciation of call-signs is also recommended: stressing numbers (six-TWO-one) or pronouncing call-sign numbers in blocks of two (six-TWENTY ONE).

- To minimise frequency change problems the survey participants suggest that air traffic controllers issue the frequency change as a single instruction, use a different pronunciation of frequencies (e.g. one-twenty-one [decimal] seven sixty five), and suggest the use of discrete 'channels' instead of frequencies.

- Two recommendations put forward by a significant group of participants are to use a single language in aviation communication (i.e. English), and secondly, to improve radio communication technology by the introduction of data link and improved voice communication equipment.

- A number of recommendations from the survey respondents require a safety study before a rational decision can be made on whether or not to implement a recommendation. Such a safety assessment needs to examine the feasibility of the recommendation in terms of safety and operational consequences and benefits, costs, timeline for implementation and possible side effects. This requires participation from the different actors involved in communication, i.e. operators, ANSPs, regulators and researchers.

Chapter 7 Recommendations

The following recommendations are made based on the results of this study:

- It is recommended that the findings of the present study be disseminated to all interested parties.

- Many recommendations suggested by pilots and air traffic controllers to avoid and minimise communication problems certainly have merit and are similar to those found in previous studies. It is recommended that pilots and controllers use standard phraseology, a slow and steady speech rate, to avoid abbreviations, to use full call-signs, to use short and concise instructions and to apply a good readback/hearback discipline.

- It is recommended that an assessment be carried out of a number of specific recommendations offered by the pilots and controllers in the current study. The purpose of such an assessment would be to examine the feasibility of the recommendations in terms of safety and operational consequences and benefits, costs, timeline for implementation and possible side effects. The following recommendations are appropriate for further study (besides the aforementioned issues the particular areas of interest will be described in brackets):

    a) The use of temporary call-signs in sectors with aircraft with similar call-signs. (Required procedures for pilots and air traffic controllers need to be identified and tested).

b) The change in call-sign assignment logic used by operators in order to minimise similar call-signs. (This requires the participation of airlines and potentially coordination between airlines. The organisational and administrative impact and coordination efforts has to be evaluated).

c) The introduction of an R/T refresher item in the recurrent training programs of pilots and air traffic controllers. (Specific problem areas such as reported in this report may be used to highlight present-day hot spots).

d) The strategic analysis of flight plans to detect similar call-signs. (‘Strategic’ means based on proposed flight schedules and repetitive flight plans of operators or based on pilot/controller reports, information typically available at CFMU. With this information operators may be contacted to investigate the potential to change the call-sign allocation of specific flights).

e) The use of data link technology (especially the use of data link to solve problems with similar call-signs, frequency changes and blocked transmissions should be studied).

Chapter 8
References

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Appendix A
Results of the air - ground communication safety literature study

The study started with a literature review on air-ground communication safety issues. The extensive library of the NLR was used for this purpose.

Readback/hearback errors

[Lintner & Buckles, 1993] states that the most common contributing factor in an incident is a "hearback, readback" error.

Perhaps the most significant of the study findings in [Monan, 1983] concerns 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. It is concluded that:

- 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

[Monan, 1988] is based on 417 voluntarily-reported incidents involving **read-back/hearback errors**. Although, these reports represent but a ripple in the main stream of hundreds of thousands of contacts, they are incontrovertible evidence that the readback/hearback problem exists and is capable of producing operational anomalies with accident risks that are far from negligible. As the study is based on voluntarily reporting, it is virtually certain that there are more actual than reported occurrences of any given kind.
The central question in this report – the repetitive airman query: “So we made a mistake. But we made a readback. Why didn’t the controller catch the error in our readback?” – is only partly answered in the findings of this study:

- The controller may have been **“observing” the readback on radar**.
- The controller may have committed a **human error** as the airman already had.

In [Monan, 1991], four major patterns of causal sources for pilot errors in their readback are given: similar aircraft call signs, only one pilot listening on the frequency, slips of mind and tongue and expectancy factors. Several precautions are recommended to reduce the likelihood of **readback/hearback errors**, like asking for verification when in doubt, using standard communication procedures, etc.

The purposes of the analysis in [Cardosi, 1994] were to examine current pilot-controller communication practices in the terminal environment. Forty-nine hours of voice tapes from local positions in ten ATC Towers were examined. There were 8,444 controller-to-pilot messages examined in this study.

The complexity of the controller’s message (i.e., the number of pieces of information) was examined and the number of **erroneous readbacks** and pilot requests for repeats were analysed as a function of message complexity. Pilot acknowledgements were also analysed; the number of full and partial readbacks, and acknowledgements only were tallied.
Less than one percent of the messages resulted in communication errors. Among the error factors examined were: complexity of the message, type of acknowledgements, use of call sign in the acknowledgement, type of information in error, and whether or not the controller responded to the readback error. Instances in which the controller contacted the aircraft with one call sign and the pilot acknowledged the transmission with another call sign were also examined. The report concludes with recommendations to further reduce the probability of communication errors.

The purpose of the study in [Cardosi, Brett & Han, 1996] and [Cardosi, Falzarano & Han, 1998] was to identify the factors that contribute to pilot-controller communication errors. Reports submitted to the Aviation Safety Reporting System (ASRS) offer detailed accounts of specific types of errors and a great deal of insight as to why they occur. The communication errors found in this study could be classified into three types: **Readback/Hearback errors** (the pilot reads back the clearance incorrectly and the controller fails to correct the error); a lack of a pilot readback, and Hearback Errors Type II (the controller fails to notice his or her own error in the pilot's correct readback or statement of intent).
Many factors contributed to these errors. The most common contributing factors were: similar call signs on the same frequency, pilot expectations (e.g., leading them to accept a clearance that they expected rather than what the controller actually said), and high controller workload. The identified results of these communication errors were (in order of prominence): altitude deviations, loss of standard separation, ATC operational errors, pilots landing on the wrong runway, and runway transgressions. The report concludes with recommendations for reducing the number of communication errors between pilots and controllers.

[Morrow, Lee & Rodvold, 1993] describes a field study of routine controller-pilot communication and the problems that disrupt this communication. Two kinds of communication problems are examined: Procedural deviations (e.g., partial readbacks) and inaccuracies (e.g., **incorrect readbacks**). The results suggest that these problems are infrequent events in routine communication. However, they are associated with communication factors such as air traffic control message length and composition and traffic level. These relations suggest potential causes of problems that disrupt routine controller-pilot communication.
Findings of this study suggest among others following general conclusions:

- Procedural deviations and **incorrect readbacks** are more frequent after controller messages with more than one or two speech acts.
- Communication efficiency is often reduced by missing acknowledge-ments because controllers tend to repeat unacknowledged messages.

[Cardosi & DiFiore, ????] presents a review of studies of communication metrics in actual operations. It summarizes what is objectively known about various aspects of communication performance, including: the number of controller transmissions per minute, the characteristics of pilot responses, **communication error rates** and the time required to transmit a message. Communication errors are defined as **readback errors** in this study. Several causal factors are discussed, like: complexity of controller's transmission, similar sounding call signs, communication equipment malfunction, blocked transmission, non-standard phraseology, speech rate and accent.

[anonymous, 1995] is based on an analysis of over 48 hours of pilot-controller communications recorded from the ground-control frequency at twelve air traffic control towers. The complexity of controller instructions is examined as well as how pilots respond to these instructions, and whether the type of response is affected by the complexity of the instructions.
Particularly studied is the effect of complexity of the instructions on communication problems, such as when pilots ask controllers to repeat their instructions or when they make an **error in the readback**. Other communication problems examined include aircraft call-sign discrepancies and conceptual errors.

The following recommendations to further improve ATC communications and thus the margin of safety in the ground-control environment arise from this investigation:

- Keep instructions short
- Listen to read backs
- Speak slowly
- Take into account potential phraseology differences and reduced English language proficiency
- Ask when not sure
- Point out similar call-signs
- Be aware of expectations

[Morrow & Rodvold, 1990] describes the investigation of a sample of routine pilot-controller communication in the TRACON environment. The paper focuses on three kinds of communication problems: inaccuracies such as **incorrect readbacks**, procedural deviations such as **missing call signs and readbacks** and non-routine transactions where pilot and controller must deal with misunderstandings or other communication problems. Preliminary results suggest these problems are not frequent events in daily operations. However, analysis of the problems that do occur suggest some factors that may cause them, like length of message, procedural deviations and non-standard language.

No pilot readback

The communication errors found in [Cardosi, Brett & Han, 1996] could be classified into three types: Readback/Hearback errors (the pilot reads back the clearance incorrectly and the controller fails to correct the error); **a lack of a pilot readback**, and Hearback Errors Type II (the controller fails to notice his or her own error in the pilot's correct readback or statement of intent). See section READBACK/HEARBACK ERRORS for more details on this report.

Hearback errors

The communication errors found in [Cardosi, Brett & Han, 1996] could be classified into three types: Readback/Hearback errors (the pilot reads back the clearance incorrectly and the controller fails to correct the error); a lack of a pilot readback, and **Hearback Errors** Type II (the controller fails to notice his or her own error in the pilot's correct readback or statement of intent). See section READBACK/HEARBACK ERRORS for more details on this report.

Communication equipment problem

Part of [Rose, 2001] deals with the influence of communication errors on airprox events in the UK. Communication events have the potential to break through two of the barriers between safe separation and a critical airprox (i.e. transmissions for normal separation and for avoidance manoeuvres). One increasing cause is the phenomenon known as a **'sleeping VHF receiver'**, which – despite much research by British Airways Engineering and NATS – still has no obvious explanation.

[Eckert & Bonahoom, 2003] gives an overview of the requirements and technical solutions for the future air-to-ground communication system. The article focuses on the ICAO/FAA selected VDL Mode 3 technology. Among others, the **stuck microphone** problem can be easily resolved within VDL Mode 3. Through channel management, the offending radio can be overridden by the controller and prevented from further transmission.

Loss of communication

Prolonged Loss of air to ground Communications (PLOC) is the subject of [Delhaise & Perry, 2003]. This document contains the sheets on the PLOC incidents investigation (EUROCONTROL) progress report. The sheets give insight into:
- Why PLOC investigation
- History of PLOC investigation
- PLOC investigation team
- Common PLOC profile (“Type A”)

In these PLOCs, most of the time:
- Duration of loss in terms of minutes
- No response to ATCO’s “Squawk Ident”

- Air-air relays failed
- Pilots claimed listening and tuned
- Pilots reported "quiet" channel
- Fault seems to be cleared when pilots pressed PTT
- Possible causes of PLOC
- Actual study of DASH-8 aircraft radio system (FMECA study) including several recommendations
- Progress in 2003

Answering the question whether Type A PLOCs will significantly decrease in coming years will require further sustained and accurate reporting.

The purpose of [Chapman, 2002] is to alert all UK operators to the continued existence of **loss of communication** incidents, the current state of the investigative process and to elicit their help in gathering as much data as possible in order to discover, then isolate and rectify the reasons for the problem(s).

Other

[Veronika Prinzo, 1996] consists of an analysis of air traffic control and pilot voice communications based on 4,500 transmissions from three air traffic control facilities (TRACONs). These transmissions have been parsed into communication elements. Each element has been assigned to a speech act category (e.g. instruction, request, etc.) and aviation topic (e.g. heading, speed, etc.). The resulting communication error statistics are given per speech act category and aviation topic, both for pilot as well as controller communications. More than 50% of controllers' and pilot's communication errors occurred in the instruction speech act category. Generally, **controllers omitted key words in their instructions, while pilots only partially read back instructions**. Possible cause of these omissions and partial read backs may be to minimise time on frequency. However, the report concludes that such strategies could create miscommunications and increase frequency congestion. Using established communication procedures and practices could eliminate some ambiguity and confusion. In parallel, the report discusses that effective and accurate communications are crucial to air safety. When ambiguities arise from poorly constructed messages, it is critical for pilots and controllers to transfer information to one another as quickly and as efficiently as possible so as to maintain or re-establish a common ground of understanding and to maintain their margins of safety.

The above mentioned omission of key words by controllers is also mentioned in [Lintner & Buckles, 1993]: sometimes **the controller begins to "shorten" the phraseology instructions** to "speed up" transmissions. At this stage, the controller is already **speaking fast**, since there is a belief among controllers that "the faster I talk, the more aircraft I can work."
Furthermore, this article refers to a report by Salt Lake City ATCT and the University of Utah in which the interesting relationship of aircraft location on communication is given: the further the aircraft were away from the airport, the more **miscommunications** occurred.

Communication errors involving aircraft call signs is the subject of [Monan, 1983]. Input to the study are 462 hazardous incident reports that are voluntarily submitted. These reports described occurrences of:

- Ambiguity

- Misperception
- Missed call up transmissions
- Missed acknowledgements

that resulted in:

- Confusion
- Disorder
- 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
- Near-collision traffic conflicts in the air and on the ground

The analysis of these incident reports resulted in five error categories 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
5. Controller failures regarding confirmation of acknowledgements or readbacks

The document finally concludes that the inability to comprehend immediately what is happening – or why it is happening – epitomises the **hazardous nature of call sign errors**.

[Veronika Prinzo & Britton, 1993] is a survey of the voice radio communications literature. The 43 reports in the review represent survey data, field studies, laboratory studies, narrative reports, and reviews. The survey topics pertain to communications taxonomies, acoustical correlates and cognitive/psycho-linguistic perspectives.
This analysis of the ATC/pilot voice radio communications literature was performed to provide an organised summary for the systematic study of interactive communications between controllers and pilots. One of the findings is that the communications taxonomies literature consistently found that **miscommunications** occurred more often when controllers experienced overload due to heavy traffic, frequency congestion, message length, etc. The report also states that only a few pieces of the communications puzzle have been presented without benefit of a complete picture on which to base accurate conclusions. Rather than try to derive a picture from the limited information, it might be better to start by defining the characteristics of daily communications and then extract normal and **miscommunications** subsets. This way, a better understanding of how big of a problem **miscommunications** exert on daily ATC/pilot operations can be obtained. Recommendations are given for new research initiatives, communications-based instructional materials, and human factors applications for new communications systems.

The purpose of [Grayson & Billings, 1981] is to discuss problems in oral communication between pilots and controllers. The investigation consisted of review and analysis of pertinent information in the ASRS database. The research team studied selected report narratives to establish ten generic types of communication problems present. Before taking up these generic communication problems, the report first considers a communication difficulty: **The expectation factor**. Pilots and controllers alike tend to hear what they expect to hear. The report concludes that many or most of the examined communication problems from the ASRS involve **human errors** on the part of the sender or receiver of the message. A small number are associated with breakdown of communications equipment, frequency saturation and other system factors.

The aim of [Wood, 1995] is to focus attention on the need for precise speech and standard phraseology when communicating by radio.

[Matchette, 1995] searches the ASRS database for records which made reference to **non-standard phraseology** and 260 reports were reviewed. Many reported incidents resulted in little more than momentary confusion or annoyance for pilots and controllers. However, nearly half the reports involved near mid-air collisions, loss of standard ATC separation, runway transgressions or other conflicts with potentially serious safety consequences. The report gives examples for common **non-standard phraseology** for each phase of flight and suggests alternate wording which may have prevented the incident.

[Matthews & Hahn, 1987] examines the factors influencing voice communication errors and evaluates proposed methods of **reducing the amount of voice communication** required in air traffic control. The paper concludes that improved transponder technology will result in less communication being required while keeping the traffic volume constant and is therefore the key to expanding both the commercial and general aviation industry.

Given the inevitability of **human error** in the ATC domain, the purpose of [McCoy & Funk, 1989] is to make a small contribution to the understanding of that error and how to mitigate its consequences. This paper describes the first steps in the study and concludes that it provided a classification of ATC errors based on a human information processing model. According to the study, it is possible to further “explain” these errors in terms of inherent human limitations, such as working memory capacity and duration limits. Next step is to identify strategies for dealing with these errors.

NASA safety analysts believe that the ASRS has seen a growth in reporting of ATC workload and communication problems during the past several years. [Morrison & Wright, 1989] undertakes a research study to verify these analysts impressions and compiled a substantial number of relevant reports to serve as a study data set. The study’s major finding concern controller experience, **workload factors that predispose controller performance errors** and ATC facility staffing: The data suggest that a substantial number of controllers are handling too much traffic, or traffic mixes that are too complex, and further indicate that accumulating more controller experience may not solve these problems.

[CAA UK, 2000] describes the study of **call sign confusion** reports in UK airspace during 1997 based on a dedicated call sign confusion database. The ACCESS group concludes that call sign confusion is a **safety problem** which can affect safe and expeditious operations in UK airspace. It also concludes that as it is practically impossible for individual airlines to allocate their own call signs in isolation, a dedicated call sign confusion cell should be established by the NATS, as major ATC service provider, to assist with this matter and to act as a monitor and mediator into call sign problems.

[SCTA, 2003] is on **call sign confusion** prevention in France. French air traffic control statistics show that the prevention of call sign similarities by SCTA is very efficient with

French airlines working in co-operation. The first way of struggling against call sign similarities is to co-ordinate work at a European level and not at all rely on a random call sign affectation. Longer term, the solution could be a real time call sign allocation in the same way as the slot allocation.

[Bürki-Cohen,????] presents arguments in favour **of realistic representation of radio communications during training** and evaluation of airline pilots in the simulator. The paper concludes that this would clearly improve the safety of the flying public.

[Baron, ????] introduces the concepts of the communication process and then uses the aviation domain to exemplify how **barriers to effective communication** may manifest themselves. Two specific areas in aviation are discussed: barriers to effective communication between pilots, and, barriers to communication between pilots and air traffic controllers (ATC). The combination of case examples, empirical research, and studies of literature, is combined to give the reader a true picture of the effects of deficient communications processes in the aviation domain.

Many documents were found dealing with **language errors** in pilot-controller communication. [Cushing, 1995] states that even when pilots and controllers both speak English fluently, there are **pitfalls in the nature of language** and the ways that language is heard. Pilots and controllers must be aware of, and avoid, common types of linguistic misunderstandings. According to [Uplinger, 1997], controllers responsible for international flights must have **skills in English** to communicate more broadly than just to repeat learned phrases. The training and testing of controllers in English should require that controllers be able to respond to unusual, as well as routine, situations. [Campbell Laird, ????] highlights the need for further research in the area of aviation English in order to help the aviation industry reach a consensus regarding communication and language policies. It is important to consider the matter globally when proposing and implementing communication and language policies. [Day, 2002] also deals with the lack of proficiency in the English language, the reason for ICAO to resolve to take steps to ensure that personnel – required to conduct radiotelephony communications in the English language – comply with a **required level of language proficiency**. Subsequently, [Mathews, 2003] points out that the introduction of more stringent language proficiency requirements (in ICAO annex amendments) underscores the need for **effective and efficient language training** programmes delivered by qualified teaching professionals. Finally, [Drury & Ma, 2002] offers among others a survey of literature on aviation language errors.

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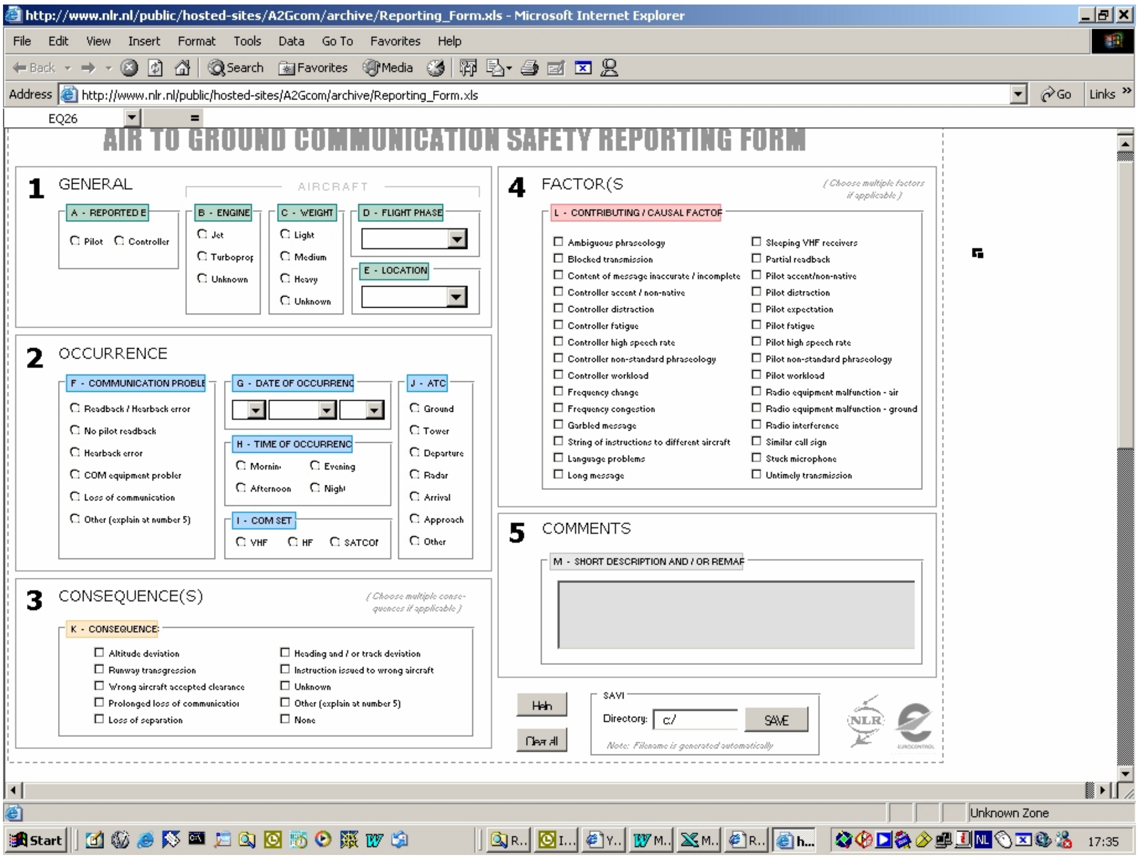
Appendix B
The reporting form for communication occurrences

The Electronic Reporting Form that was created for the reporting campaign is inserted below. This form was accessible through the Internet (project web site) and could be filled in by Flight Safety Officers of ANSP and airlines when reporting air-ground communication occurrences to the NLR project team.


http://www.nlr.nl/public/hosted-sites/A2Gcom/archive/Reporting_Form.xls - Microsoft Internet Explorer
AIR TO GROUND COMMUNICATION SAFETY REPORTING FORM
1 GENERAL
AIRCRAFT
A - REPORTED BY
Pilot
Controller
B - ENGINE
Jet
Turboprop
Unknown
C - WEIGHT
Light
Medium
Heavy
Unknown
D - FLIGHT PHASE
E - LOCATION
2 OCCURRENCE
F - COMMUNICATION PROBLEM
Readback / Hearback error
No pilot readback
Hearback error
COM equipment problem
Loss of communication
Other (explain at number 5)
G - DATE OF OCCURRENCE
H - TIME OF OCCURRENCE
Morning
Evening
Afternoon
Night
I - COM SET
VHF
HF
SATCOM
J - ATC
Ground
Tower
Departure
Radar
Arrival
Approach
Other
3 CONSEQUENCE(S)
(Choose multiple consequences if applicable)
K - CONSEQUENCES
Altitude deviation
Runway transgression
Wrong aircraft accepted clearance
Prolonged loss of communication
Loss of separation
Heading and / or track deviation
Instruction issued to wrong aircraft
Unknown
Other (explain at number 5)
None
4 FACTOR(S)
(Choose multiple factors if applicable)
L - CONTRIBUTING / CAUSAL FACTORS
Ambiguous phraseology
Blocked transmission
Content of message inaccurate / incomplete
Controller accent / non-native
Controller distraction
Controller fatigue
Controller high speech rate
Controller non-standard phraseology
Controller workload
Frequency change
Frequency congestion
Garbled message
String of instructions to different aircraft
Language problems
Long message
Sleeping VHF receivers
Partial readback
Pilot accent/non-native
Pilot distraction
Pilot expectation
Pilot fatigue
Pilot high speech rate
Pilot non-standard phraseology
Pilot workload
Radio equipment malfunction - air
Radio equipment malfunction - ground
Radio interference
Similar call sign
Stuck microphone
Untimely transmission
5 COMMENTS
M - SHORT DESCRIPTION AND / OR REMARKS
Help
Clear all
SAVE
Directory: c:/
SAVE
Note: Filename is generated automatically
NLR
EUROCONTROL

Appendix C
The survey questionnaire on air - ground communication safety

The survey of air traffic controllers and airline pilots that was organised is described in this appendix. Professional organisations representing pilots and controllers, such as the local Airline Pilot Associations and the IFATCA were contacted to spread the news on the survey under their members.

Below the information on the survey that was put on the Internet to inform participants on the initiative and survey itself is presented.

C.1 Information for participants of the survey

ABOUT THIS SURVEY
WHY THIS SURVEY? Commissioned by EUROCONTROL, the National Aerospace Laboratory NLR conducts a study into the safety of air-ground communication between pilots and controllers. The focus of the study lies on communication problems within Europe. As part of this study, a safety survey among pilots and air traffic controllers is held. The objective of this survey is to identify lessons learned and collect potential safety recommendations on the subject. The survey is designed to help you - the air traffic controller or pilot - to express your opinions regarding the air to ground communication safety. The survey will run until 1 March 2005. **HOW TO USE THIS SURVEY?** Just start with question number 1 and follow the instructions in the survey. After filling out the survey, submit the survey by pressing the "submit" button at the bottom of the page. Filling out and submitting the survey will take about 5 - 10 minutes depending on the number of occurrences you have experienced. Apart from the uniquely numbered questions, the survey has also been divided into three parts: **Part A** requests some general information about the respondent, his/her employment and experience. **Part B** seeks the respondent's opinion on matters concerning air to ground communication safety. **Part C** can be used for remaining general remarks on the subject and/or remarks on the survey itself. **YOUR ANONYMITY** Anyone who has submitted this survey is guaranteed anonymity. Survey respondents are never asked to enter their name or other personal identifying information. So, when you use this system to submit your survey response, you can be assured that your identity is unknown and cannot be determined by any means. Therefore, the air-ground communication safety project team cordially asks you to fill out this survey without any restraint. Your responses to the survey will yield valuable information for the air-ground communication safety study. Survey results will help NLR and EUROCONTROL researchers to determine solution strategies and recommendations for improvement of air to ground communication.

C.2 Air-ground communication safety survey questionnaire

Part A - General Information

1. What is your nationality?
2. What is your native language?
3. What is your second language?
4. What is your employment?

Pilot - - - - - - - - - - - -> continue with Question 5
Air traffic controller - -> continue with Question 11

Questions to be filled out by PILOTS

5. What type of aircraft do you mainly fly?
   Jet
   Turboprop
   Other

NOTE: In the remainder of this survey denoted as "the aircraft"

6. In what capacity do you fly the aircraft?
   Captain
   First officer
   Second officer
   Other

7. What routes do you mainly fly?
   Domestic (not crossing international borders)
   International short haul (crossing one international border)
   International long haul (crossing two or more international borders
   Intercontinental (crossing continental border(s))

8. Approximately how many flight hours have you logged (all types)?

9. Approximately how many flight hours did you log on the aircraft the last 12 months?

10. Approximately how many sectors did you fly as pilot flying in the last 90 days?

Continue with Question 15

Questions to be filled out by CONTROLLERS

11. What part of ATC do you mainly work in?
    Ground
    Tower
    Departure
    Radar
    Arrival
    Approach
    Other

12. How many years have you been working in ATC as controller?

13. Approximately how many hours do you work as air traffic controller per year?

14. How many aircraft do you handle per hour on average?

Continue with Question 15

Part B - Air-Ground Communication Occurrences

Questions to be filled out by both PILOTS AND CONTROLLERS

SIMILAR CALL SIGNS

15. Have you ever encountered an air-ground communication occurrence of the type Similar call signs?

YES - - - -> continue with Question 16
NO - - - -> continue with Question 19

16. What is the frequency with which you have encountered this type of occurrence?
    once a week
    once a month
    once per six months
    once a year
    less than once a year

17. What are the factor(s) that caused or contributed to this occurrence?
    Ambiguous phraseology
    Blocked transmission
    Content of message inaccurate/incomplete
    Controller accent/non-native

Controller distraction
Controller fatigue
Controller high speech rate
Controller non-standard phraseology
Controller workload
Frequency change
Frequency congestion
Garbled message
Issue of a string of instructions to different aircraft
Language problems
Long message
Sleeping VHF receivers
Partial readback
Pilot accent/non-native
Pilot distraction
Pilot expectation
Pilot fatigue
Pilot high speech rate
Pilot non-standard phraseology
Pilot workload
Radio equipment malfunction - air
Radio equipment malfunction - ground
Radio interference
Similar call sign
Stuck microphone
Untimely transmission

18. From your own experience, what are the lessons learned on this occurrence and what would you recommend in order to improve communication for this particular type of occurrence? (i.e. to prevent or mitigate this particular type of occurrence)

SLEEPING VHF RECEIVER

Loss of communication type in which the VHF frequency becomes silent for a period of time.

19. Have you ever encountered an air-ground communication occurrence of the type Sleeping VHF receiver?

YES - - - -> continue with Question 20
NO - - - -> continue with Question 23

20. What is the frequency with which you have encountered this type of occurrence?

    once a week
    once a month
    once per six months
    once a year
    less than once a year

21. What are the factor(s) that caused or contributed to this occurrence?

    Ambiguous phraseology
    Blocked transmission
    Content of message inaccurate/incomplete
    Controller accent/non-native
    Controller distraction
    Controller fatigue
    Controller high speech rate
    Controller non-standard phraseology
    Controller workload
    Frequency change
    Frequency congestion
    Garbled message
    Issue of a string of instructions to different aircraft
    Language problems
    Long message
    Sleeping VHF receivers
    Partial readback
    Pilot accent/non-native
    Pilot distraction
    Pilot expectation
    Pilot fatigue
    Pilot high speech rate

Pilot non-standard phraseology

Pilot workload

Radio equipment malfunction - air

Radio equipment malfunction - ground

Radio interference

Similar call sign

Stuck microphone

Untimely transmission

22. From your own experience, what are the lessons learned on this occurrence and what would you recommend in order to improve communication for this particular type of occurrence? (i.e. to prevent or mitigate this particular type of occurrence)

FREQUENCY CHANGE

The 'Frequency change' factor occurs when the pilot forgets to change the frequency or uses a wrong frequency.

23. Have you ever encountered an air-ground communication occurrence of the type Frequency change?

YES - - - -> continue with Question 24
NO - - - -> continue with Question 27

24. What is the frequency with which you have encountered this type of occurrence?

once a week

once a month

once per six months

once a year

less than once a year

25. What are the factor(s) that caused or contributed to this occurrence?

Ambiguous phraseology

Blocked transmission

Content of message inaccurate/incomplete

Controller accent/non-native

Controller distraction

Controller fatigue

Controller high speech rate

Controller non-standard phraseology

Controller workload
Frequency change
Frequency congestion
Garbled message
Issue of a string of instructions to different aircraft
Language problems
Long message
Sleeping VHF receivers
Partial readback
Pilot accent/non-native
Pilot distraction
Pilot expectation
Pilot fatigue
Pilot high speech rate
Pilot non-standard phraseology
Pilot workload
Radio equipment malfunction - air
Radio equipment malfunction - ground
Radio interference
Similar call sign
Stuck microphone
Untimely transmission

26. From your own experience, what are the lessons learned on this occurrence and what would you recommend in order to improve communication for this particular type of occurrence? (i.e. to prevent or mitigate this particular type of occurrence)

NON-STANDARD PHRASEOLOGY

27. Have you ever encountered an air-ground communication occurrence of the type Non-standard Phraseology?

YES - - - -> continue with Question 28
NO - - - -> continue with Question 31

28. What is the frequency with which you have encountered this type of occurrence?
once a week
once a month
once per six months

once a year
less than once a year

29. What are the factor(s) that caused or contributed to this occurrence?
Ambiguous phraseology
Blocked transmission
Content of message inaccurate/incomplete
Controller accent/non-native
Controller distraction
Controller fatigue
Controller high speech rate
Controller non-standard phraseology
Controller workload
Frequency change
Frequency congestion
Garbled message
Issue of a string of instructions to different aircraft
Language problems
Long message
Sleeping VHF receivers
Partial readback
Pilot accent/non-native
Pilot distraction
Pilot expectation
Pilot fatigue
Pilot high speech rate
Pilot non-standard phraseology
Pilot workload
Radio equipment malfunction - air
Radio equipment malfunction - ground
Radio interference
Similar call sign
Stuck microphone
Untimely transmission

30. From your own experience, what are the lessons learned on this occurrence and what would you recommend in order to improve communication for this particular type of occurrence? (i.e. to prevent or mitigate this particular type of occurrence)

BLOCKED TRANSMISSION

31. Have you ever encountered an air-ground communication occurrence of the type Blocked transmission?

YES - - - -> continue with Question 32
NO - - - -> continue with Question 35

32. What is the frequency with which you have encountered this type of occurrence?
    - once a week
    - once a month
    - once per six months
    - once a year
    - less than once a year

33. What are the factor(s) that caused or contributed to this occurrence?
    - Ambiguous phraseology
    - Blocked transmission
    - Content of message inaccurate/incomplete
    - Controller accent/non-native
    - Controller distraction
    - Controller fatigue
    - Controller high speech rate
    - Controller non-standard phraseology
    - Controller workload
    - Frequency change
    - Frequency congestion
    - Garbled message
    - Issue of a string of instructions to different aircraft
    - Language problems
    - Long message
    - Sleeping VHF receivers
    - Partial readback
    - Pilot accent/non-native
    - Pilot distraction
    - Pilot expectation
    - Pilot fatigue
    - Pilot high speech rate
    - Pilot non-standard phraseology

Pilot workload
Radio equipment malfunction - air
Radio equipment malfunction - ground
Radio interference
Similar call sign
Stuck microphone
Untimely transmission

34. From your own experience, what are the lessons learned on this occurrence and what would you recommend in order to improve communication for this particular type of occurrence? (i.e. to prevent or mitigate this particular type of occurrence)

RADIO INTERFERENCE

For instance, interference often comes from music stations on the ground.

35. Have you ever encountered an air-ground communication occurrence of the type Radio Interference?

YES - - - -> continue with Question 36
NO - - - -> continue with Question 39

36. What is the frequency with which you have encountered this type of occurrence?
    once a week
    once a month
    once per six months
    once a year
    less than once a year

37. What are the factor(s) that caused or contributed to this occurrence?
    Ambiguous phraseology
    Blocked transmission
    Content of message inaccurate/incomplete
    Controller accent/non-native
    Controller distraction
    Controller fatigue
    Controller high speech rate
    Controller non-standard phraseology
    Controller workload
    Frequency change

Frequency congestion
Garbled message
Issue of a string of instructions to different aircraft
Language problems
Long message
Sleeping VHF receivers
Partial readback
Pilot accent/non-native
Pilot distraction
Pilot expectation
Pilot fatigue
Pilot high speech rate
Pilot non-standard phraseology
Pilot workload
Radio equipment malfunction - air
Radio equipment malfunction - ground
Radio interference
Similar call sign
Stuck microphone
Untimely transmission

38. From your own experience, what are the lessons learned on this occurrence and what would you recommend in order to improve communication for this particular type of occurrence? (i.e. to prevent or mitigate this particular type of occurrence)

Part C - Remarks & suggestions

39. Here you are given the opportunity to voice your remaining remarks on the air-ground communication safety issue and / or to voice suggestions on additional air-ground communication safety topics not yet covered in this survey.

Appendix D EUROCONTROL invitation to airlines and ANSPs

Dear Sir / Madam,

EUROCONTROL has launched a new safety initiative to improve air-ground communication safety. Within this initiative, the National Aerospace Laboratory (NLR) of the Netherlands has been commissioned to conduct and manage a reporting campaign on air-ground communication safety occurrences.

The objective of the reporting campaign is to better understand air-ground communication occurrences and identify potential prevention strategies. The project team will need data on air-ground communication occurrences from flight crew and air traffic controllers who have been involved in such an occurrence. This will not affect in any way the current normal reporting arrangements. We ask you to participate in the reporting campaign, thereby supporting this safety initiative.

The project team has set-up a special ‘Air-Ground Communication Safety’ web site for the reporting campaign at:

http://www.nlr.nl/public/hosted-sites/A2Gcom/index.html

This site provides more information on this safety initiative and the electronic Reporting Form to record air-ground communication safety occurrences by Airlines and ANSP Safety Officers. If you wish to provide reports in your own format (for example BASIS output) you can email them directly to the NLR project manager Mr. Rombout Wever (wever@nlr.nl). Received reports will be dis-identified and confidentially handled by the project team, because the purpose of the project is to identify air-ground safety occurrences, the causal factors and safety recommendations, and not to apportion blame etc. No personal details will thus be made available to NLR, EUROCONTROL or the reporter’s organisation or any other entity outside the project team. The reporting campaign will run from 25 October 2004 through 1 February 2005.

The success of this project will depend on the number and the quality of the reports received. Since the aim of the initiative is to improve air-ground communication safety, it is clearly in the interests of all of us to support this initiative. In anticipation, the project team is grateful for receiving your reports and is confident that they will contribute to safer operations.

Yours faithfully,

Dr. Erik MERCKX

Head of Safety Enhancement Business Division

Printed at EUROCONTROL, DGS, Bureau LOG/Logistics & Support Services
96, rue de la Fusée
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