THE VOCABULARY OF AVIATION RADIOTELEPHONY COMMUNICATION IN SIMULATOR EMERGENCIES AND THE CONTRADICTIONS IN AIR TRAFFIC CONTROLLER BELIEFS ABOUT LANGUAGE USE

BY

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Abstract

This thesis encompasses a mixed methods enquiry into the language used in air traffic control in simulated emergency situations in the United Arab Emirates. The workplaces studied employ pilots and controllers from a diverse range of language backgrounds. This research sets out to answer three questions:

1. What is the technical vocabulary of aviation radiotelephony in emergency training in the simulator?
2. To what extent is technical vocabulary used in radiotelephony in emergency training in the simulator?
3. What factors influence the use of technical vocabulary in speaking?

The first part of the study investigates the nature of technical language in aviation radiotelephony. Two spoken corpora were created from recordings of three air traffic controllers from two different workplaces (Ghaf and Sandy aerodromes), undergoing emergency simulator training. Mandated standard phraseology formed a written corpus. Standard phraseology is an international language defined by the International Civil Aviation Organisation (ICAO) and adopted by governments for use in radiotelephony communication. Quantitative analysis showed that the technical vocabulary in aviation radiotelephony consists of proper nouns, numbers, aviation alphabet, acronyms, technical word types and multiword units. The technical word types included purely technical words e.g. *taxiway* and cryptotechnical vocabulary (high, medium and low frequency words with a technical meaning (Fraser, 2009)) e.g. *approach*. Multiword units included ICAO standard phraseology e.g. *hold short* or subsidiary and local phraseology in the spoken corpora e.g. *Do you have any question* (subsidiary) and *engine start approved* (local).

The second part of the study examines sources of difference in language use by controllers. Technical vocabulary coverage differed between the spoken corpora at 70.52% for Ghaf Aerodrome and 51.61% for Sandy Aerodrome. Two explanations for this were: differences in the purpose of emergency training in each aerodrome; and differences in linguistic style by the Sandy controller which was established through keyword analysis. Interviews with nine controllers established further factors which are likely to affect the use of technical

vocabulary in radiotelephony communication including: communication styles of native English speakers (NES) and non-native English speakers (NNES).

Further examination of interview data also revealed contradictory beliefs underlying language use by controllers. Their beliefs diverge around the role of standard phraseology, its use (or not) in emergencies and the value of language training for emergencies. This divergence reflects the contradictions in definitions of standard phraseology and plain language in the literature. Differences in language use can lead to frequent miscommunication and the need for clarification of meaning in these UAE workplaces.

The present study makes two contributions to the significant body of research on aviation radiotelephony. The first is an Aviation Radiotelephony Word and Number List. It is used to clarify the role of technical vocabulary and plain language in radiotelephony and to show how the technical vocabulary coverage of radiotelephony communication, in an extract from the simulator emergency training and another extract from an ICAO document, is high compared to other professions. Second, a Model of Controller Beliefs and Outcomes is presented and suggests a way to interpret divergent language outcomes in radiotelephony. The model summarises two contradictory sets of controller beliefs about standard phraseology, language in emergencies, and training. Further, the language and training outcomes reflect those beliefs.

The investigation concludes with implications for training and testing in aviation for ab initio and experienced controllers. The corpora, word and number list and model all provide useful tools for the training and testing needs in these UAE workplaces. The chapter concludes with limitations of the study and future research directions.

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Aviation Terms

Term	Definition
ICAO Annex	There are 19 ICAO annexes which contain the regulatory requirements for aviation (see SARPs below)
Approach controller	The approach controller uses radar to sequence aircraft for landing and departure. They hand aircraft over to the tower controller for landing and aircraft are passed from the tower controller to the approach controller once they have taken off
ICAO Document	Documents identify how the SARPs in ICAO Annexes are to be implemented
GCAA	General Civil Aviation Authority - the government body in the UAE which oversees all aviation activity and ensures compliance with regulations
Ground controller	A controller who is responsible for all aircraft and vehicle movements around the aerodrome, except for the runway
Holding point	A threshold next to the runway at which an aircraft waits until the pilot is given permission to taxi onto the runway
ICAO	International Civil Aviation Organisation
Local phraseology	a term used in this paper to mean multiword units that replace ICAO standard phraseology e.g. *engine start approved* replaced *start-up approved*
LPR	Language Proficiency Requirements. This refers to the requirement by ICAO that all non-native English speakers (NNES) reach a minimum level of English language proficiency. This requirement was implemented in 2011 and NNES must prove their language ability to retain their license to practise as an air traffic controller or pilot
POB	Persons on Board
Radiotelephony	Communication between air traffic controllers and other personnel including, but not limited to, pilots, other air traffic controllers, emergency vehicle drivers, emergency services and engineering personnel which is conducted over the radio
SARPs	Standards and Recommended Practises provided in ICAO regulatory Annexes

SOP	Standard Operating Procedures - these are the rules that aviation personnel must follow in order to do their job. They are contained in manuals in each workplace
Standard phraseology	multiword units contained in ICAO Documents and mandated by governments to be used in air traffic control communication
Subsidiary phraseology	multiword unit(s) developed for a particular standard operating procedure(s), in an individual workplace or country which is not covered in the ICAO documents. Subsidiary phraseology is used in addition to standard phraseology
Taxi	describes the movement of an aircraft from one part of an airport to another via taxiways. It means the same as drive for a car.
Tower controller	A controller who is responsible for all aircraft and vehicle movements onto and off the runway. They are responsible for clearing departing and landing traffic to take-off or land
UAE	United Arab Emirates

Linguistic Terms

Term	Definition
ESP	English for specific purposes
MWU	Multiword Unit: composed of two or more words and/or numbers
NES	Native English Speaker
NNES	Non-Native English Speaker

Chapter 1 Introduction

Aviation English has been the subject of numerous academic studies across a range of topics. Arguments have been made for a broad definition of aviation English as an English for Specific Purposes (ESP) which encompasses the language needs of a variety of aviation personnel such as pilots, cargo handlers and maintenance staff (Cutting, 2012; Wang, 2007, 2008). Other studies examine teaching aviation English as an ESP (Roberts, 2018; Roberts & Orr, 2020; Roberts et al., 2019). Studies about cognitive factors (Barshi & Farris, 2013; Farris et al., 2008), effect of accents (Tiewtrakul & Fletcher, 2010), pronunciation (Kim & Billington, 2018) and speech recognition (Delpech et al., 2018; Smidl et al., 2019) have focussed on language use in aviation. Further research focuses on language testing and proficiency requirements (Alderson, 2009, 2011; Huhta, 2009; Mathews, 2004; Mell, 2004a, 2004b; Read & Knoch, 2009; Shawcross, 2004). The current study focuses on vocabulary and sources of miscommunication in multilingual environments in the radiotelephony language used by air traffic controllers.

This research was conducted in the United Arab Emirates (UAE) to find out more about the language used in simulator emergencies in air traffic control. Recordings were made of emergency simulator training for two aerodromes (Ghaf and Sandy) at GAL ANS Training Centre. Interviews were conducted with air traffic controllers from Ghaf, Sandy, Desert and Dune aerodromes to learn about the sources of difference in language use in the workplace. Pseudonyms have been used.

1.1 Background - Emergency training in the simulator

This study was conducted in an air traffic control simulator for two reasons. First, emergency training is essential for air traffic controllers to retain their licence to work in the UAE. The training is done in an air traffic control simulator for at least four hours per year (GCAA, 2016). Second, I could not get permission to conduct this research in air traffic control workplaces.

The simulator training consists of a series of exercises, each including one or more emergencies and taking thirty to forty-five minutes. The simulator mirrors the controller's work environment as closely as possible. The controller sits at a workstation; uses a headset; has flight strips to identify aircraft; and uses a phone line for coordination with other controllers. The controller can see the airport as if they were in their workplace. They talk to pilots and see aircraft respond just as they would on the job.

The focus of the emergency training is not usually language. However, controllers employed by GAL ANS must be proficient in general English to Level 4 according to criteria set by the International Civil Aviation Organisation (ICAO, 2018) since language proficiency equips controllers and pilots to successfully resolve emergencies (ICAO, 2010). That said, since aviation English is a safety critical aspect of emergencies, it is essential that the language of all users is better understood in order to inform training and testing needs.

1.2 Why this study?

There are three reasons I wanted to do this research. First, I listened to a student with good English stumble over the phrase *startup and pushback approved* in week 9 of her 12-week air traffic controller course. She was corrected by the instructor. I felt that she should be fluent in basic phrases by week 9, but the combination of air traffic control training and language training together seemed to hamper her progress. Radiotelephony language training outside the air traffic control simulator could help her fluency (Drayton & Kelly, 2019). Second, I had always understood that plain or possibly general English language was needed in emergencies rather than standard phraseology. Standard phraseology is an international language defined by the International Civil Aviation Organisation (ICAO) and adopted by governments for use in radiotelephony communication. When I listened to emergency training by experienced air traffic controllers, I heard standard phraseology. My colleague explained that this was because emergencies can be resolved by experienced personnel with standard phraseology. Another colleague told me about a civil airport emergency with a tyre bursting on take-off. He described the incident as having been dealt with smoothly and that the language used was ‘all phraseology’. Third, my colleagues stated that non-native English speakers (NNES) were better at radiotelephony communication. To help my students do better in the simulator, I wanted to know more about the language used in emergencies.

At the time the data was gathered, I was a course developer for GAL ANS Training Centre, writing courses for air traffic controllers that focussed on safety. Prior to that, I taught English to students who would go on to train as air traffic controllers. I was interested in preparing students for the challenges they would face in their training and wanted to know more about the language they would be required to use. I was also interested in the importance of language in radiotelephony communication to safety.

1.3 A change of direction

Initially, I wanted to know when or how standard phraseology and plain language are used in emergencies. I thought their use would be clearly delineated in radiotelephony, however it proved difficult to distinguish one from the other. Further, the International Civil Aviation Organisation (ICAO) documents contained contradictions in the definitions of standard phraseology and plain language. Models of how standard phraseology and plain language are combined were useful but did not help me to make judgements about what to count as standard phraseology or plain language. Any analysis which attempted to separate standard phraseology and plain language would be subjective, difficult to carry out, and produce questionable results. The difficulty encountered in trying to measure the extent to which standard phraseology or plain language are used in aviation radiotelephony is best demonstrated with the use of an example. The sentence below is an instruction from an air traffic controller to a pilot taken from the recorded data in the current research project.

> *(1) You can ah taxi and exit at Delta. (2) Do you just want to hold on taxiway tango then? (Sandy Aerodrome Corpus).*

In the example above, it is clear that the words *taxi, exit, delta, hold, taxiway* and *tango* are technical words in aviation radiotelephony. However, it is difficult to identify if they should be counted as standard phraseology or as plain language. Neither sentence (1) nor (2) matches sentences found in the ICAO Document 9432 Manual of Aviation Radiotelephony, yet they are both highly technical. Should they be counted as plain language since plain language is highly technical (Estival & Farris, 2016)? Or should *exit at Delta* in the first sentence be counted as standard phraseology since it differs from *Exit kilo* (ICAO, 2007, p. 5.2) by one word, means the same, but *exit kilo* is used with a vehicle rather than an aircraft? In the second sentence, the word *hold* is used to ask the aircraft if they wish to stop on *taxiway tango*. In the radiotelephony document, *hold* is used with *short (hold short)* to tell a pilot or vehicle to stop before the runway; it is used to tell an aircraft to stay within a certain area in the air; and finally with *position* to tell an aircraft to stop where they are

(ICAO, 2007). The meaning in the sentence above is closest to *hold position,* but it has been shortened to *hold*. Should this be counted as standard phraseology or plain language? This example shows how impractical the division into standard phraseology and plain language is in practice.

Consequently, I turned to an applied linguistics approach for identifying technical vocabulary in texts. This approach produced an Aviation Radiotelephony Word and Number List which I used to learn more about the nature of specialist language in aviation radiotelephony and its coverage. The list helped clarify what technical vocabulary is used in radiotelephony and how controllers use it. It also provided a way to analyse air traffic control interactions to understand what was being communicated, how it was communicated and why. The technical vocabulary analysis and information gained from interviews provided a clear picture of training needs for ab initio and experienced controllers. The analysis confirms that communication in aviation radiotelephony uses a highly technical, coded language (Estival & Farris, 2016). It is beyond English for Specific Purposes (ESP) since such a characterisation places the onus for learning the language on non-native English speakers (NNES) (Douglas, 2014). The language of aviation radiotelephony is highly complex and needs to be learnt by all users, including native English speakers (NES) (Clark, 2017; Estival, 2016). Any language-based approach to teaching should combine the skills of a language teaching professional with the highly specialised knowledge and skills of an aviation specialist because of the safety critical nature of radiotelephony communication.

1.4 Aims of the study

The study aims to establish the nature of technical vocabulary used in air traffic control emergency simulator training and the extent to which it is used. It further examines the factors which influence differing use of technical vocabulary by air traffic controllers. The intention is to identify training and testing needs in a UAE air traffic service (ATS) provider. To meet these aims, this research investigates three questions:

1. What is the technical vocabulary of aviation radiotelephony in emergency training in the simulator?

2. To what extent is technical vocabulary used in radiotelephony in emergency training in the simulator?
3. What factors influence the use of technical vocabulary in speaking?

1.5 Overview of the thesis

This introductory chapter has provided the background, motivation, change in research direction and purpose of the research. It includes an overview of the thesis and the research questions investigated.

Chapter 2 reviews plain language and standard phraseology which are the two main components of aviation radiotelephony. They are not clearly defined by ICAO and there are contradictions in the literature. Contradictions also exist around the language used to resolve emergencies. The second part of the chapter explores corpus analyses of radiotelephony. Next, it outlines the use of corpus analysis to identify technical vocabulary and research language use. The chapter concludes with an exploration of research which identifies the sources of difference in radiotelephony language use by aviation professionals in multilingual environments.

Chapter 3 outlines the methodology of the study. The first section provides details of participant recruitment, data collection and interview procedures. The preparation of the corpora for quantitative analysis is described along with tagging procedures. Quantitative corpus analysis to create a technical wordlist, establish coverage and a keyword analysis of controllers' speech is outlined. Qualitative analysis of interviews with nine controllers is explained.

Chapter 4 first presents the quantitative findings of the study, responding to research questions one and two. The findings include an Aviation Radiotelephony Word and Number List, and identification of the technical vocabulary in aviation radiotelephony. Technical vocabulary coverage is presented. The answers to question three are drawn from a quantitative keyword analysis and interview data, highlighting reasons for variation in controller language.

Chapter 5 compares the coverage of technical vocabulary in emergency simulator training to other professions and shows that it is a highly technical language. Next, the Aviation

Radiotelephony Word and Number List is used to examine two language extracts to clarify the purpose and nature of plain language in radiotelephony communication. The chapter presents a Model of Controller Beliefs and Outcomes which reflects findings on standard phraseology and plain language from this study. This model links controller beliefs to divergent language use and training outcomes.

The final chapter summarises the key findings in this study. The implications of the Aviation Radiotelephony Word and Number List and Model of Controller Beliefs and Outcomes for training and testing are examined. The chapter concludes with limitations, suggestions for future research, and concluding remarks.

Chapter 2 Literature review

This chapter examines the context in which this study takes place by reviewing literature related to aviation radiotelephony and relevant vocabulary research. It highlights some of the issues and contradictions in the field and identifies the gaps which led to the research questions stated in Chapter 1. The chapter is divided into three parts. The first investigates the elements of aviation radiotelephony language. The second examines corpus analysis to: investigate language use in radiotelephony; and identify technical vocabulary. The third explores relevant sources of miscommunication in aviation.

2.1 What is the language of aviation radiotelephony?

This section explains the components of aviation radiotelephony. First, it explores the standard phraseology contained in civil aviation documents, then reviews academic literature related to standard phraseology. Second, plain language is examined from a regulatory perspective, followed by its description in academic research. A contradiction in the literature around what constitutes plain language is identified. Models for how standard phraseology and plain language are used in spoken radiotelephony are examined. Finally, the contradictions inherent in the literature about the use of standard phraseology and plain language in emergencies are explored. Note that, standard phraseology and ICAO standard phraseology are used interchangeably as are the terms controller and air traffic controller.

2.1.1 Standard phraseology and subsidiary phraseology

ICAO (2007) makes a series of points about standard phraseology. First, the standard phraseology contained in ICAO and government documents is not exhaustive and should not be considered as such (GCAA, 2018; ICAO, 2007, 2016b). Standard phraseologies may be supplemented by additional subsidiary phraseologies. Standard phraseology and subsidiary phraseology must be used by ground personnel as well as pilots and controllers. That is, any aviation personnel, including vehicle drivers and emergency services, who speak to air traffic controllers must use this mandated language. Finally, plain language can be subsidiary phraseology.

The regulations for the use of standard phraseology are contained in a series of ICAO manuals which are called Annexes or Documents. The first of these is “Annex 10

Aeronautical Telecommunications Volume II, Communication procedures including those with [Procedures for Air Navigation Services] PANS status" (ICAO, 2016a). Air navigation service is the provision of air traffic control to keep aircraft (and vehicles) safe on the ground and in the air. Annex 10 identifies the standards and recommended practices (SARPs) to be achieved by United Nations member states. With regard to standard phraseology, ICAO states:

> ICAO standardized phraseology *shall* be used in all situations for which it has been specified. (ICAO, 2016a, p. 5.1 emphasis added).

The word *shall* establishes ICAO standard phraseology as mandatory in air traffic control communication. Annex 10 provides the groundwork for two ICAO Documents ("Document 4444 Procedures for Air Navigation Services: Air Traffic Management" and "Document 9432 Manual of Radiotelephony") which cover the procedures for standard phraseology and provide examples of the language. These manuals are legally binding once they are implemented by a government in a national document (ICAO, 2016b) as they are in the UAE document: "Civil Aviation Advisory Publication (CAAP) 69 UAE Radiotelephony Standards". CAAP 69 references the three ICAO documents mentioned above (GCAA, 2018) and makes standard phraseology a legal requirement in all air traffic control communication. It includes examples of phrases which relate to specific standard operating procedures, such as the example given in Extract 2.1.

Extract 2.1

2.1 Extract of a routine pilot controller exchange

Turn and Speaker	**Transmission**
1 Pilot:	GROUND PAKISTAN 222 REQUEST TAXI
2 Air Traffic Controller:	PAKISTAN 222 GIVE WAY TO BOEING 747 PASSING LEFT TO RIGHT TAXI TO HOLDING POINT RUNWAY 02
3 Pilot:	HOLDING POINT RUNWAY 02 GIVING WAY TO BOEING 747 PAKISTAN 222

Extract from GCAA (2018, p. 38 capitals in original).

There are four points to note in this example. First, this exchange follows the dialogue structure of a pilot initiated call which is: pilot call, air traffic control response / instruction, pilot readback of instruction (Estival, 2016). Second, the pilot is asking for taxi instructions to get to the runway in Turn 1. There are two parts to the request. Standard phraseology prescribes how speakers will identify themselves and others (ICAO, 2007, 2010, 2016a, 2016b), so the pilot addresses the controller (*ground*) and identifies who is speaking using the aircraft callsign (*Pakistan 222*). Then, the pilot requests taxi instructions. Third, the controller responds (Turn 2) by instructing the aircraft to *taxi to the holding point*, a position just before the entrance to a runway at which the aircraft must wait for permission to enter the runway. The number *02* tells the pilot the direction of the runway for take-off, and therefore which holding point to use. Finally, the pilot must give way to an aircraft *(Boeing 747)* before taxiing. Fourth, in Turn 3, the pilot reads back the instruction (known as a readback) while the controller listens to ensure the readback is correct (Estival, 2016; Koble & Roh, 2013) and the flight crew executes the manoeuvre (Barshi & Farris, 2013; Howard, 2008). Extract 2.1 is an example of the language to be used for the Standard Operating Procedure (SOP) to taxi to the holding point for an aircraft which intends to take-off. Each example of standard phraseology is related to an SOP in this way (Howard, 2008; Mitsutomi & O'Brien, 2003). In each case, the order information is presented in a transmission follows that prescribed by ICAO (Estival, 2016; ICAO, 2016b).

Subsidiary phraseology is a subset of standard phraseology. It is used for operating procedures which are not covered in the ICAO documents, but are specific to a country or an airport. Subsidiary phraseology supplements standard phraseology identified in international and national documents, but must not replace it (ICAO, 2007). Just like standard phraseology, subsidiary phraseology must be clear, concise and unambiguous (ICAO, 2007, 2016a, 2016b). Subsidiary phraseology can include plain language phrases (ICAO, 2007, p. 3.2). It is not possible to provide an example of subsidiary phraseology here since it is not contained in any of the above documents but would be included in the standard operating procedures manual for an air traffic control centre.

Standard phraseology provides brief and efficient communication but differs from the English language on which it is based. The first difference is the grammar used. Standard phraseology has restricted grammatical structures (Estival, 2016; Intemann, 2008; Moder, 2013). The continuous tense is used to describe an ongoing action e.g. *holding position,* the future tense is rare and confirmation of a completed action is given in the passive voice e.g. *brakes released* (Intemann, 2008). Standard phraseology lacks pronouns, articles and determiners (Intemann, 2008; Lopez, Condamines, & Josselin-Leray, 2013). In Extract 2.1, callsigns *(ground, Pakistan 222)* replace *I* and *you*; and the controller says *give way to Boeing 747* (*a* or *the* before Boeing is omitted). Further, standard phraseology uses imperatives rather than full sentences or interrogatives (Intemann, 2008; Moder, 2013) such as *taxi to holding point* and *request taxi* in Extract 2.1.

The second difference is in the vocabulary used. Standard phraseology consists of a number of multiword units (MWUs) or collocations (Bratanić & Anić, 2010) which each have a single precise meaning (Bieswanger, 2016; Lopez, Condamines, Josselin-Leray, et al., 2013). Extract 2.1 contains the MWUs: *request taxi, give way to (giving way to), passing left to right, taxi to,* and *holding point.* These MWUs are commonly used in aviation and have one meaning. Further, aviation radiotelephony consists of a limited specialised vocabulary set (Intemann, 2008; Moder, 2013). The words have been carefully chosen to avoid phonological similarity e.g. *climb* is used as the antonym for *descend* (Intemann, 2008). Numbers and letters are delivered in specific ways e.g. *alpha* for the letter *A,* and *niner* for nine, so that nine is not confused with the number five over the radio (Estival, 2016; ICAO, 2007; Moder, 2013). Finally, the pronunciation of radiotelephony communication typically lacks intonation, rhythm and pauses (Estival & Molesworth, 2009). Trippe and Baese-Berk (2019) found that the difference between the rhythm of aviation communication and standard American English was as distinct as between two different languages such as British English and French or Dutch and Italian. These structural and vocabulary elements of standard phraseology make it more efficient than English for communication between air traffic controllers and pilots over the radio in routine situations (Borowska, 2017; Kim & Elder, 2009; Lopez, Condamines, Josselin-Leray, et al., 2013; Ragan, 1997; Varantola, 1989).

Finally, standard phraseology can only be understood by experts (Borowska, 2017; Lopez, Condamines, Josselin-Leray, et al., 2013; Trippe & Baese-Berk, 2019). It relies on shared understanding which allows the interlocuters to minimize their linguistic and cognitive load in carrying out tasks (Hüllen, 1981; Lopez, Condamines, & Josselin-Leray, 2013; Moder, 2013; Moder & Halleck, 2009). This shared understanding is captured in an example from

Bullock (2015) in which he discusses the phrase 'ABC123, going around' said by a pilot. This short phrase tells the controller that the pilot is cancelling their landing; will fly over the runway; and then inform the controller of their intentions. This short phrase is immediately understood by the controller and no further information is required until the pilot identifies their intentions. Not only does this phrase highlight the shared understanding by pilot and controller, it also demonstrates how effective communication is clear, concise and unambiguous. Further, the relationship of this phrase to the procedure of 'going around' is also clear. Finally, the volume of information implied helps explain why radiotelephony language cannot be understood by laypeople.

2.1.2 Plain language

The ICAO definitions regarding plain language appear contradictory and are confusing. One set of ICAO documents identifies plain language in relation to standard phraseology (ICAO, 2007, 2016a, 2016b). Another ICAO document defines it from a general English perspective (ICAO, 2010). In the first set of documents, no definition is given for plain language and its role is ambiguous. Section 2.1.1 identified that plain language could be used as subsidiary phraseology to provide standard phrases unique to a particular location which become part of the local standard operating procedures. However, plain language is also used in a more immediate sense when standard phraseology is insufficient. The ICAO documents related to radiotelephony communication all contain a phrase similar to:

> Only when standardized phraseology cannot serve an intended transmission, plain language *shall* be used (ICAO, 2016a, p. 5.1 emphasis added).

In other words, plain language serves two purposes: as subsidiary phraseology; and as the language to be used when there is no standard phraseology. In both cases, plain language must be clear, concise and unambiguous in keeping with the requirements of standard phraseology (ICAO, 2007, 2016b). In these documents, plain language appears to be based on standard phraseology. However, it appears to be defined simultaneously as a possible subset of standard phraseology (subsidiary phraseology) and as language which is broader than standard phraseology.

Another definition for plain language bases it on natural English. In a separate ICAO document, plain language is defined as 'The spontaneous, creative and non-coded use of a given *natural* language' (ICAO, 2010, p. x emphasis added) which is qualified as being:

> constrained by the functions and topics (aviation and non-aviation) that are required by aeronautical radiotelephony communications, as well as by specific safety-critical requirements for intelligibility, directness, appropriacy, non-ambiguity and concision (ICAO, 2010, p. 3.5).

and qualifies this by saying that the term *plain* was chosen rather than *general*, *common*, *extended* or *natural* since *plain* is used in other ICAO documents (ICAO, 2010, p. x). In the same document, ICAO asserts: 'There is simply no more suitable form of speech for human interactions than natural languages' (ICAO, 2010, p. 1.2), suggesting that the definition for plain language is based on general English. This definition implies that plain language may replace standard phraseology if confusion arises. Other authors also suggest that natural or plain English replaces ICAO phraseology (see: Intemann (2008); Lopez, Condamines and Josselin-Leray (2013)). Finally, ICAO states that the term plain language is not to be confused with the plain language movement in the UK and USA which advocates plain language for legal and medical purposes and is a simplified form of technical language (Estival & Farris, 2016; ICAO, 2010). How plain language is also a technical language is not defined in any of the ICAO documents. However, plain language in aviation may still be highly technical and understood only by the professionals who use it (Estival & Farris, 2016; Hüllen, 1981; Varantola, 1989), just as standard phraseology is.

The literature is contradictory and vague about what constitutes plain language. Firstly, it is not clear how it is simultaneously a technical language and natural English. If it is used as a natural language which replaces standard phraseology, then plain language should be comprehensible to laypeople, but it is not. Perhaps plain language is technical when it is used as subsidiary phraseology in which case, it may not be plain language. While some studies identify the inclusion of greetings, signoffs, politeness markers, and questions as further examples of plain language (Intemann, 2008; Moder, 2013) used to maintain cooperative relationships with controllers or pilots (Hansen-Schirra, 2013; Lopez, Condamines, & Josselin-Leray, 2013; Moder, 2013), the overall nature of plain language remains unclear.

2.1.3 How are standard phraseology and plain language combined?

Three models explain how plain language and standard phraseology intersect in aviation radiotelephony. The first is a three tier division of standard phraseology, English for Specific Purposes (ESP), and finally, English for general purposes in which standard phraseology is represented by a rectangle at the centre around which plain language forms a larger rectangle followed by general English (Bullock, 2015). This model suggests that standard phraseology is at the centre and may be replaced by general English in certain circumstances. However, Bullock's description is more nuanced as he provides examples in which all three elements may be contained in communication, or there are varying combinations of standard phraseology and ESP, or ESP and general English. The second model is by Mitsutomi and O'Brien (2003). Again, standard phraseology is the central element with ESP and general English expanding out from that. However, Mitsutomi and O'Brien (2003) seem to advocate for using general English when standard phraseology is insufficient. Bieswanger (2016) presents a third model which identifies standard phraseology and plain language as two registers in aviation radiotelephony. Plain language is an aviation English register with its own lexical, grammatical and pronunciation features, while standard phraseology is the other register. Both registers are interchangeable and must be learned. In these models, which include different categories or registers of language, there is no clear indication of what counts as standard phraseology or plain language when the two are combined (Prado & Tosqui-Lucks, 2019).

2.1.4 Standard phraseology and plain language in emergencies

While there has been a great deal written about the contribution of language errors to aviation accidents (see e.g. Campbell-Laird (2004); Cookson (2009); Domogala (1991); Estival and Farris (2016); Estival and Molesworth (2009); Green (1991); Varantola (1989)), there has been very little written about the language used in emergencies that are successfully resolved. The literature appears to contain contradictions about whether standard phraseology or plain language is used in emergencies. Some writers state that air traffic communications often deviate from standard phraseology in emergency situations towards a more conversational style (Campbell-Laird, 2004; Yan, 2007) or that more plain language is used in emergencies and unusual situations (Bullock, 2017; ICAO, 2010; Moder, 2013; Prado & Tosqui-Lucks, 2019) because standard phraseology is insufficient for these situations (Yan, 2007). Read and Knoch (2009) state that there is an assumption that more plain language is used in emergencies. Conversely, other authors claim that standard phraseology is useful for routine and emergency situations, but not one-off unpredictable (unusual) situations (Mitsutomi & O'Brien, 2003; Varantola, 1989). Further, air traffic controllers are expected to be silent during emergencies because the pilots are busy in the cockpit and should not be disturbed (Emery, 2014; ICAO, 2007). Three language related causes are identified as the causes of aviation accidents and incidents: not using correct standard phraseology; lack of language proficiency; and the use of more than one language in the same airspace (ICAO, 2010). These three causes imply that both standard phraseology and plain language may be important in emergencies. However, it is unclear from the literature if standard phraseology or plain language or a mix of the two is used in emergencies which are successfully resolved.

2.2 What does corpus analysis say about aviation radiotelephony?

Corpus analysis of aviation radiotelephony language has been used in aviation for training student air traffic controllers and pilots. Three studies are relevant to this research. In the first, Sullivan and Girginer (2002) carried out a discourse analysis of nine hours of transcribed recordings of air traffic controller – pilot conversations in an air traffic control centre in Ataturk, Turkey. The recordings were supplemented with questionnaires from 25 controllers and 25 pilots; and interviews with 10 controllers and 10 pilots. The study noted differences in the way numbers are said compared to ICAO regulations and the addition of greetings and closings in the data, as well as exchanges conducted in Turkish. Controllers and pilots stated they needed more practise in conversational English since they often need to supplement standard phraseology with general English. The study was done because one researcher was a teacher of ab initio pilots and controllers, so the corpus was used to develop training materials for use in an ESP classroom. Sullivan and Girginer (2002) appear to have retained standard phraseology and plain language in their corpus, but this is not discussed in their paper.

A second corpus study by Prado and Tosqui-Lucks (2019) compiled examples of non-routine situations for research purposes and classroom use. Their goal was to collect unusual situations, so that they would have a database of plain language use. They collected recordings from the ATC.net website dated from 2008 onwards. They retained the sound files and also made transcriptions. They used an ICAO document to identify categories of non-routine incidents and aimed to gather three recordings for each one. The final corpus was of 12 hours of transcribed audio which resulted in 110 737 words, in a total of 130 texts categorised into 31 occurrence types. They were unable to determine the language background of many of their speakers, but tried to include recordings of non-native and native English speakers since they wanted to investigate language use from an English as a lingua franca perspective (see, for example, Estival and Farris (2016), Kim and Elder (2009)). Each transcript began when a problem was first mentioned and finished when the problem was solved or handed to another professional. Prado and Tosqui-Lucks (2019) used this corpus to examine word frequency and are currently conducting research on the structure and vocabulary areas of the ICAO language proficiency requirement (LPR) rating scale (which can be found in ICAO (2018)) and plan to also use the corpus to investigate fluency and interaction according to the proficiency scale. The authors have used the corpus to examine how plain language is used in aviation radiotelephony with a focus on how this is represented in the ICAO LPR rating scale (for information about the rating scale see, for example: Farris (2016a, 2016b)). However, the paper itself is a description of the corpus and its compilation, concluding with suggestions for how it could be used to enhance research of aviation English rather than with findings about plain language use.

Finally, Lopez, Condamines, Josselin-Leray, et al. (2013) compared a spoken corpus to a written corpus to better understand how spoken radiotelephony compares to the ICAO standard phraseology. The written corpus was created from the French government civil aviation radiotelephony document (similar to the GCAA document in Section 2.1.1) and the ICAO Document 9432 Manual of Radiotelephony (discussed in Section 2.1.1) to capture both national and international language requirements (Lopez, Condamines, & Josselin-Leray, 2013; Lopez, Condamines, Josselin-Leray, et al., 2013). This written corpus established the 'prescribed norm' for air traffic controller – pilot interactions. The spoken corpus was created from 22 hours of recordings of pilot - air traffic controller communication, recorded in an air traffic control tower and two area control facilities. Before examining the data, speech disfluencies, non-English politeness and greeting markers, proper nouns, aviation alphabet letters, hapaxes (words that appear once), and numbers were removed (Lopez, Condamines, & Josselin-Leray, 2013; Lopez, Condamines, Josselin-Leray, et al., 2013). The study established lexical differences between spoken and prescribed language in the corpora. The differences were in the use of nouns, adjectives, interjections, determiners and pronouns (Lopez, Condamines, Josselin-Leray, et al., 2013). In a separate paper, Lopez, Condamines and Josselin-Leray (2013) further identified that the word *can* was used by controllers to politely convey authority in instructions such as *you can fly heading 3-2-5.* The authors suggest that the corpus can be used to provide examples of language use in the classroom and that the differences between the written and spoken corpus can be used to highlight language use such as the use of *can* or *may* by aviation professionals.

The study by Lopez, Condamines, Josselin-Leray, et al. (2013) could be strengthened by retaining all the data. The removal of items from the corpora including proper nouns, letters and numbers substantially reduced the size of the corpora as Table 2.1 shows.

Table 2.1

2.1 The effect of removing vocabulary items on corpus size in study by Lopez, Condamines, Josselin-Leray, et al. (2013)

	Written corpus (initial size)	Final size	Reduction	Spoken corpus (initial size)	Final size	Reduction
Types	805	**566**	**29%**	1,238	**408**	**67%**

Table data from Lopez, Condamines, Josselin-Leray, et al. (2013).

The table gives the number of word types before and after the removal of items e.g. the number of types in the written corpus was 805 before removal and 566 afterwards, a reduction of 29%. The word types in the spoken corpora were reduced by 67%. Consequently, conclusions about standard phraseology and plain language are drawn from 33% of the data in the spoken corpus (Lopez, Condamines, Josselin-Leray, et al., 2013). It is possible that retaining all items in the corpora would have provided information about the amount and nature of technical vocabulary in each text which may allow for a richer analysis of language use.

2.2.1 What is technical vocabulary?

This section examines the characteristics of technical vocabulary. A definition is provided by Coxhead (2017):

> Technical vocabulary would generally be expected to be limited in range to its specialised subject area or discipline and to be well known and regularly used by professionals in that field. People outside the specialised field might have a limited knowledge of that vocabulary, or might have never heard or come across these technical items at all. In some cases, the meaning of a word might be vaguely known by laypeople, but a specialist would be expected to know much more precise information about its meaning, use and nuances (p. 22).

There are a number of common elements in technical vocabulary. It often consists of word types since only one or two members of a word family may be technical (Coxhead, 2017). That is, where a word family consists of more than one related word type such as *walk*, *walks* and *walking,* technical vocabulary in a particular field usually contains one or two word type(s) from the word family (Nation, 2016; Nation & Webb, 2011). Further, a focus on word types over word families ensures that words, which might be removed from analysis if word families are the unit of analysis, are retained (Ha & Hyland, 2017). Also, Coxhead (2017) states that proper nouns appear as technical language in disciplines such as medicine and history, and in trades such as carpentry. Another important language component which may form part of technical language is multiword units. These are phrases 'made up of words that frequently occur together' (Nation, Shin, et al., 2016, p. 71) including two word collocations and three or more word bundles (Coxhead, 2017). Identifying technical vocabulary provides information about the nature of specialised language.

2.2.2 Corpus analysis to examine technical vocabulary

Corpus analysis provides a way to identify more technical or cryptotechnical words and phrases. One method, used in the trades and academia, for identifying technical vocabulary is to compare a specialised corpus with a general language corpus (Chung & Nation, 2004; Coxhead, 2017) such as Nation (2020) BNC/COCA word family lists (Coxhead et al., 2020). In the initial comparison, specialised vocabulary is immediately highlighted because it does not appear in general corpus lists (Coxhead, 2017; Nation, Coxhead, et al., 2016). From there, an analysis is made of the remaining words which appear in both lists to identify technical words for the specialist area being studied (Coxhead, 2017). This method has been used previously to create wordlists of technical vocabulary in carpentry (Coxhead et al., 2016; Coxhead et al., 2020), plumbing (Coxhead & Demecheleer, 2018; Coxhead et al., 2020), fabrication (Coxhead et al., 2019; Coxhead et al., 2020), and automotive trades (Coxhead et al., 2020). The technical wordlists were used to identify range of words (just found in one trade, or across all four); word frequency in each trade; and types of technical vocabulary including single words, multiword units, abbreviations and proper nouns (Coxhead et al., 2020). Identifying technical vocabulary to create a wordlist provides useful information about the nature of language.

Creation of specialist wordlists from a corpus also allows the percentage of technical vocabulary in a text to be established (Coxhead, 2017; Nation, Coxhead, et al., 2016). This was done in each of the trades. Table 2.2 gives the coverage for all four trades and for an academic medical textbook to show typical technical vocabulary load in a range of fields. For example, carpentry shows that 10.69% of spoken language consists of technical vocabulary. In the written corpus, this figure is almost four times higher. Essentially, one in ten words in the spoken corpus is technical and in the written corpus, this figure is two words in five. The table shows that there is typically three to four times more technical vocabulary in written corpora than in spoken corpora. A written academic textbook has similar coverage to these trade texts.

Table 2.2

2.2 Coverage of technical language in written and spoken corpora

Technical vocabulary list	Spoken corpus	Written corpus
Carpentry	10.69%	38.35%
Plumbing	11.59%	34.48%
Fabrication	9.18%	30.47%
Automotive	12.75%	37.44%
Anatomy textbook		37.6%

Table 6.5: Coverage results for all four LATTE technical word lists, abbreviations, and proper nouns from Coxhead et al. (2020) is adapted here. The figure for the anatomy textbook is from Chung and Nation (2004).

In aviation, research of technical vocabulary and coverage is limited. Two studies examine technical vocabulary. The first study by Pannebecker (2019) identified examples of content words which were categorised as nouns (*runway, heading, tower, pilot, American, sir*), numerals (*zero, one, two, three … thousand*), adverbs (*now, up*), interjections (*o, ah*), verbs (*cleared, turn*) and adjectives (*heavy, left, right, okay*). The second study examined the use of twelve general English words which are technical words in aviation e.g. *taxi, take-off,* *descend* and *climb*. Hüllen (1981) described these words as having a scientific slant in the specialist context of air traffic control communication. In this context, the words describe experiences exactly and there is little flexibility for manipulating their meaning. Hüllen (1981) concludes that general English words in aviation English become specialist words, not because of frequency, or preferred grammar or style, but mostly because of semantic use and context. This description fits with what Fraser (2009) calls cryptotechnical language, which is vocabulary that includes high, medium and low frequency words which look like everyday words, but have a technical meaning that may not be immediately obvious (see also, Coxhead (2017)). In the study by Lopez, Condamines, Josselin-Leray, et al. (2013) proper nouns were one of several items removed from the corpus, suggesting that technical vocabulary may have been contained in the data eliminated from their research (discussed in Section 2.2.1). In terms of coverage, a study by Shin and Kim (2005) found pilots and controllers estimated standard phraseology made up 70% of their communication. However, no quantitative analysis has been done of aviation radiotelephony which shows the extent of standard phraseology or technical vocabulary in aviation.

The composition and coverage of aviation technical vocabulary in aviation radiotelephony communication has not been established. Although some aviation radiotelephony technical vocabulary has been described, a study such as those completed in the trades has not been done. Further, the coverage of technical vocabulary in aviation radiotelephony has not been established. This study seeks to investigate the nature of technical vocabulary contained in aviation radiotelephony communication, and to establish its coverage in simulated emergency situations.

2.3 Factors that influence the use of technical vocabulary in aviation

There are a range of factors that may influence the use of technical words in aviation: language background, experience and technical knowledge. The United Arab Emirates is a multilingual environment with pilots and controllers from a range of language backgrounds. Language backgrounds are a source of miscommunication in aviation radiotelephony. For example, Kim and Elder (2009) identified an unusual situation in Korean airspace where a native English speaking (NES) pilot asked a non-native English speaking controller for a diversion to another airport. The pilot's request was long, containing a lengthy plain language explanation of why they needed a diversion. As a result, the controller did not immediately understand the request. A possible reason for the long explanation could be 'justification' (Moder, 2013; Sänne, 1999) derived from a need to explain an unexpected request and recognition of the extra workload it creates for controllers (Moder, 2013). Interviews with non-native English speaking (NNES) aviation personnel found that they thought the explanation was wordy, unnecessary and the request could have been made using standard phraseology (Kim & Elder, 2009). Bieswanger (2013) also found that a NES controller used wordy, confusing language which could have been more easily communicated with standard phraseology.

In a later study by Kim and Elder (2015), also in South Korea, aviation personnel reported that experience, technical knowledge and situational awareness were essential elements of successful communication in aviation. They were critical of the language proficiency requirements contained in ICAO (2018) since they do not address these three elements. Language tests in South Korea do not address them either. Consequently, the Korean aviation language test had meant personnel with knowledge and experience in aviation were disadvantaged and/or lost their jobs. These experienced personnel would be replaced by younger less experienced professionals with higher language proficiency but lacking in knowledge. Such a situation could create another risk to aviation safety. Further, there was no requirement in the testing policy for NES to adjust their language use to meet the needs of aviation in environments where language proficiency varies. Participants in the study stated that NES's tended to overuse plain language and this created miscommunication (see Day (2004); Howard (2008)). Such language use results in extended communication to clarify meaning (Field, 2020).

In another study, Kim (2018) found that a lack of technical knowledge was a source of miscommunication. Lack of knowledge on the part of a controller resulted in an interaction with a pilot which lasted more than 17 minutes and consisted of more than 100 transmissions. Both interlocuters were NNES, but the pilot had low English language proficiency and excellent technical knowledge. Conversely, the controller had good English language proficiency, but poor technical knowledge. Kim (2018) showed that the pilot request for a diversion could have been solved if the controller had the requisite technical knowledge. In interviews, aviation personnel were critical of the lack of technical knowledge of the controller and felt that this was the cause of miscommunication rather than the pilot's language proficiency. Good general language ability does not predict success in understanding aviation English radiotelephony (Moder & Halleck, 2009; Trippe, 2018).

A study by Knoch (2014) found that pilots were critical of speakers who lacked technical knowledge or were not fluent in radiotelephony. This investigation asked pilots, air traffic controllers and language experts to appraise the language use of aviation personnel in recordings. One goal in the study was to identify what aviation personnel thought was important to successful and safe communication in radiotelephony. The aviation personnel judged the speakers' ability to transition from standard phraseology to plain language as they would be required to do on the job. Aviation experts expected that users could use both interchangeably (Elder et al., 2017; Kim, 2018; Knoch, 2014) and were critical of a user who did not have the flexibility to smoothly transition from one to the other. They were also critical of speakers who lacked the technical knowledge to carry out the task (Knoch, 2014).

This section focused on research that identified several areas of potential miscommunication each resulting in language use with different proportions of standard phraseology or plain language. The first is the difference in language use by NNES and NES aviation personnel. The second is technical knowledge or a lack of it. The third is the ability to transition smoothly from standard phraseology to plain language. Deviations from standard phraseology are a precursor to miscommunication (Day, 2004; Howard, 2008) and language proficiency does not predict success in aviation radiotelephony. Finally, miscommunication leads to the need for clarification of meaning. This study seeks to identify what controllers in the UAE regard as causing language variation which leads to miscommunication.

2.4 Summary of literature review

This chapter has outlined the nature of aviation radiotelephony by first examining standard phraseology which is the language mandated by ICAO for use in routine situations. Next, the chapter explained plain language and found its definitions unclear and contradictory. The literature is also unclear about how standard phraseology and plain language are combined in aviation radiotelephony, but it is generally accepted that they are intertwined. The literature on their use in emergencies is likewise contradictory, from more plain language being used in emergencies to standard phraseology being enough. At the same time, air traffic controllers must be silent during emergencies. The chapter also explored previous corpus research on aviation radiotelephony and reasons for miscommunication related to the use of standard phraseology and plain language. This current research proposes to investigate the nature of technical vocabulary in aviation radiotelephony in an air traffic control simulator, the extent to which it is used and the factors that affect its use in the workplace. Chapter 3 outlines the methodology used in this research.

Chapter 3 Methodology

This chapter contains three sections. The first section is the background which outlines the location of the research, the participants and ethics. The second section presents the data collection methods and includes the principles of corpus development for the spoken and written corpora, followed by the data collection method for interviews. The third section identifies the data analysis undertaken. It describes problems encountered with the tools for analysis of aviation radiotelephony language. Next, it explains tagging of proper nouns and numbers for retention and comparison between corpora. Then, the principles used to create a technical word and number list are outlined. The methodology for keyword analysis is presented. Finally, the interview data analysis for themes is explained.

3.1 Background

Data collection for this research took place at the GAL ANS Training Centre, Al Ain, United Arab Emirates. The spoken corpus was created from recordings of two emergency training sessions in air traffic control simulators at the centre. Controllers were from Ghaf Aerodrome and Sandy Aerodrome. Interviews included controllers from Desert and Dune airports.

3.1.1 Participants

A total of nine participants took part in this research. They were chosen by convenience sampling (Friedman, 2012; Rothwell et al., 2016). Eight were air traffic controllers who arrived at the training centre to do emergency continuation training and were asked if they would be willing to take part in the research. The final participant was asked to take part in the research during an unrelated meeting and an interview was scheduled for a later date. Two Ghaf controllers and one Sandy controller were recorded in the simulator; and interviews were conducted with four more Ghaf controllers and one more controller each from Dune and Desert Airports. The participants were all licensed tower controllers who worked in the UAE. Seven of the controllers worked at military bases (Ghaf and Sandy aerodromes), while the remaining two worked at civilian airports which handle military traffic (Dune and Desert Airports). Their experience ranged from five to thirty-nine years and they had worked in the UAE between one and twelve years.

Table 3.1

3.1 Research participants

First language (L1)	Number of participants	Second language(s) (L2)	Places worked
Arabic	3	English	UAE
Arabic	1	English	UAE, Turkmenistan, Pakistan, Kazakhstan
Arabic	1	English Comprehension only: Hindi	UAE
English	1	N/A	USA, Afghanistan, UAE
English	1	Spanish	USA, Korea, Japan, Italy, Honduras, Iraq, Afghanistan, UAE
Swedish	1	English, German, French	Sweden, Estonia, Latvia, Lithuania, Nigeria, Namibia, Saudi Arabia, UAE
Estonian	1	English Comprehension only: Russian, Finnish	Estonia, UAE

Table 3.1 shows the participants come from a range of language backgrounds. Eight out of nine controllers speak more than one language. Seven of the participants speak English as a second language and one speaks English only. Of those who have worked outside the UAE, two have worked in English-speaking countries, and all have worked in non-English speaking countries. Three participants took part in the recorded simulator sessions on two separate occasions, two Emirati controllers and one American controller. All participants took part in interviews.

3.1.2 Ethics

The Victoria University of Wellington Human Ethics Committee approved this research (reference number: 0000027733) (see Appendix A). In order to protect the identity of participants, pseudonyms are used for their names and workplaces.

3.2 Data collection

The first section below discusses corpora collection and the second focuses on the interview data. Two corpora were created for quantitative analysis. The first was based on data gathered in air traffic control simulators and the second was developed from the main written texts for aviation radiotelephony. Qualitative data was gathered from interviews with controllers.

3.2.1 Spoken corpus

Simulators have built-in recording equipment which was utilised to record the training sessions. Table 3.2 shows the five different emergencies recorded. Ghaf Aerodrome included three emergencies shown in column three. There were two controllers: a tower controller who controlled all aircraft entering, exiting, landing and taking off on the runway; and a ground controller who controlled all aircraft on taxiways and aprons. The Sandy Aerodrome controller worked alone and covered ground and tower control tasks. The total number of running words in each corpus was 1749 tokens in Ghaf and 1433 in Sandy. This number of tokens makes these corpora very small in a field of academic study where a corpus of approximately 110 000 words is regarded as small (Prado & Tosqui-Lucks, 2019). Consequently, the findings related to the spoken corpora are not generalisable to a larger population. In this study, corpus analysis is combined with qualitative interview data to give a better understanding of the language used in Ghaf and Sandy Aerodromes only. A bigger study is needed to verify the results of this research.

Table 3.2

3.2 Ghaf and Sandy Aerodrome spoken corpora emergencies

Air Traffic Control Unit	Length of exercise	Emergency	Controllers
Ghaf Aerodrome	90 minutes	1. Smoke in cabin 2. Engine flame-out 3. Brake failure	2 controllers: one ground controller; one tower controller
Sandy Aerodrome	48 minutes	1. Co-pilot incapacitated 2. Bird strike/engine on fire	1 controller – working as both ground and tower controller

Prior to analysis, the spoken corpus was prepared according to the protocols below:

1. The start of each emergency was signalled by the words: *Mayday* or *Pan-pan* (GCAA, 2018; ICAO, 2007, 2016a, 2016b), so all transmissions including, and after these words were included in the corpus. Transmissions prior to *mayday* or *pan-pan* were not included.
2. One item that was corrupted in recording was replaced in the line ** *fuel endurance* in the Ghaf corpus. This was changed to *2 hours fuel endurance* because 2 was mentioned in a response that followed.
3. False starts e.g. *traf traffic* were retained.
4. Changes in instructions were retained e.g. *They're going to relocate to/ actually if you'd like to go to Delta, you can follow the aircraft onto the runway after he lands* (Sandy Aerodrome, 33:23).
5. Greetings and politeness markers such as: *Sir, thankyou* and *good day* were retained.
6. Marginal words were retained such as *um, ah, aah.* Contractions and colloquial pronunciations (*gunna* for going to, *ya* for you) were retained (Nation, 2016).

3.2.2 Written corpus

UAE and international documents were used to create a written corpus. The local (UAE) General Civil Aviation Authority (GCAA) *CAAP 69 UAE Radiotelephony Standards* document (GCAA, 2018) and ICAO *Document 9432 Manual of Radiotelephony* (ICAO, 2007) were combined just as Lopez, Condamines, Josselin-Leray, et al. (2013) did in their study. Since the recordings were made in a tower simulator, the written corpus contained language related to tower control only, in contrast to Lopez, Condamines, Josselin-Leray, et al. (2013) whose corpus included all types of air traffic control. The principles used in establishing the written corpus are outlined below:

1. Only the chapters related to tower control were included (see Table 3.3).

Table 3.3

3.3 Chapters from ICAO and GCAA documents included in the written corpus

GCAA CAAP 69	ICAO Doc 9432
Chapter 2 General procedures and phraseology, Chapter 3 Aerodrome control, Chapter 7 Distress and urgency, and Chapter 9 Vehicle procedures and phraseology (GCAA, 2018).	Chapter 2 General operating procedures; Chapter 3 General phraseology; Chapter 4 Aerodrome control aircraft; Chapter 5 Aerodrome control: vehicles; Chapter 9 Distress and urgency procedures and communications failure procedures; Chapter 10 Transmission of meteorological and other aerodrome information; and Chapter 11 Miscellaneous flight handling (ICAO, 2007).

2. Phrases related to approach or area control were not included. For example, *descend to flight level two five zero* is not relevant to tower control because it is said by an approach controller;
3. Standard phraseology for use between a vehicle driver and a controller was included, but standard phraseology for use between a vehicle driver and aircraft was excluded;
4. Phrases are given in block capitals in the original documents and capitalisation was retained;
5. If an entry identified more than one possibility, then all possibilities were included. For example: RIGHT (or LEFT, or NOSE) WHEEL APPEARS UP (ICAO, 2007capitals in original) became:

    RIGHT WHEEL APPEARS UP

    LEFT WHEEL APPEARS UP

NOSE WHEEL APPEARS UP;

6. The word ‘or’ was removed between two possible options and both were included as two separate items. For example, the following text became two separate lines of text in the corpus:
   RUNWAY 09 CLEARED TO LAND FOR FULL STOP G-CD
   or
   G-CD MAKE ANOTHER CIRCUIT REPORT DOWNWIND (capitals in original);
7. Duplicates were retained e.g. FASTAIR 345 WILCO (capitals in original) appeared three times on one page and was kept in the corpus;
8. All numbers and proper nouns were included.

3.2.3 Interviews

The second set of data was interviews with nine controllers, including six from Ghaf Aerodrome, one from Sandy Aerodrome and two from two civil airports, Desert Airport and Dune Airport. Interview questions were designed to find out the source of differences in the language used by controllers. Ten questions asked about the participants’ background, the context of their work, their opinions about sources of miscommunication and about training (see Appendix B). The interviews were semi-structured (Friedman, 2012) and conducted in English. Interviews ranged in length from 6 ½ minutes to 44 minutes. Recording the interviews allowed us to focus on the questions, and made the process less intrusive (Friedman, 2012). A mobile phone was used and tested prior to the first interview to ensure the quality of recording would be adequate (Duff, 2012). Initially, seven interviews were completed, but two further interviews followed with controllers from Desert and Dune airports. The extra interviews were with civil aviation air traffic controllers to widen the scope of the research and find out if civil controllers experienced the same issues as military controllers. The interviews were transcribed orthographically (Adolphs & Carter, 2013). Repetitions were included. Transcription only included information which would answer the questions asked (Loewen & Philp, 2012; Révész, 2012).

3.3 Data analysis

This section focuses on the creation of the word and number list, keyword analysis and interview analysis.

3.3.1 Adapting tools for aviation language

Initially the Lextutor Range programme was used to analyse the written and spoken corpora (Cobb, n.d.). However, several difficulties arose from the results. In Lextutor, numbers are not included in the output and proper nouns are listed, but their meaning and purpose in relation to aviation required specialist knowledge to interpret or could not be identified. Here is an example of proper nouns, numbers, abbreviations and aviation alphabet from the written corpus in this study:

FASTAIR 345 CLEARED TO KENNINGTON, VIA A1 FL 280 WICKEN 3 DELTA DEPARTURE, SQUAWK 5501 (ICAO, 2007, p. 2.13).

The text is a clearance given by a controller to a pilot before the aircraft engines are started (ICAO, 2007, p. 2.13) and the numbers represent part of a callsign, a flight level, a departure route and a squawk code (ICAO, 2007, 2016b). Lextutor produced:

fastair number cleared to kennington via a number fl number wicken number delta departure squawk number

The composition of each number is not shown in this result. The analysis also shows that when proper nouns and numbers are removed, the text is halved from sixteen tokens to eight:

cleared to via a fl delta departure squawk

If the abbreviation 'fl' and aviation alphabet letter 'a' are removed, the text is further reduced as follows:

cleared to via departure squawk

The sentence 'cleared to via departure squawk' makes no sense in radiotelephony. The removal of numbers, proper nouns and abbreviations has significantly changed the meaning and quantity of this text and it no longer represents the original corpus.

Further analyses of proper nouns, numbers, aviation alphabet and abbreviations were carried out on the written corpus with Wordsmith (Scott, 1996), Lextutor (Cobb, n.d.), AntConc (Anthony, 2019) and Range (Heatley et al., 2002). Analyses included:

- Wordlists with AntConc and WordSmith;
- N-gram and concordance analyses with Lextutor and AntConc. An N-gram is a sequence of words and N stands for the number of words in the sequence (Nation, Shin, et al., 2016).
- Range analysis based on Nation (2020) BNC/COCA word family lists using the Range Programme developed by Heatley et al. (2002). This programme showed how proper nouns and aviation alphabet were distributed throughout the lists (Nation, 2016).

The results of analyses with these tools were inconsistent. Numbers and proper nouns with the same purpose were either counted separately or lost, meaning that comparisons across corpora were difficult to make. The meaning of numbers was unclear or items appeared in a list according to the number rather than the information conveyed. This means, for example, that N-grams with the same meaning were listed separately throughout the N-gram list. Ultimately, corpus tools were able to identify some information, but this was often limited and comparisons of proper nouns, numbers, abbreviations and aviation alphabet between corpora was inconclusive.

3.3.2 Tagging the corpora to retain proper nouns and numbers

As a consequence of the inconclusive results with the corpora in their original form, the written and spoken corpora were manually tagged to retain data and make the corpora comparable. The tags replaced the proper nouns, numbers and aviation alphabet that they represent. Scott and Tribble (2006) used a similar method in which they tagged parts of speech by adding a letter(s) to denote that item, for example, *THE_DET*, *OF_PRP* (*the* determiner, *of* preposition). In the current study, tags replaced proper nouns and numbers with the same meaning. Such items were identified and categorised by using the ICAO (2016b) Document 4444 Procedures for Air Navigation Services: Air Traffic Management. Tagging retained all items in the written and spoken corpora and had the dual benefit of allowing comparison across corpora while ensuring that as much information as possible could be extracted in spite of the small size of the sample.

Table 3.4 gives an example of a tagged transmission. The information contained in each column is explained below:

- The first column contains the transmission broken down into parts. The meaning of proper nouns and numbers was found in ICAO (2016b) and presented in column two with the formatting from the original document. Italicised items in brackets are substitutable; and phrases in capital letters do not change.
- The tags created are given in column three. For example, *FASTAIR 345* is an aircraft callsign (ICAO, 2016b) shown in italics and brackets. The words *CLEARED TO* do not change. *FASTAIR 345* is not comparable across corpora, and 'aircraft call sign' would be counted as three unrelated words in corpus analysis.
- The tag *(ACCALLSIGN)* replaced *FASTAIR 345* in column three.

The tags replaced proper nouns and numbers in the phrase, so the resulting text was: *(ACCALLSIGN) CLEARED TO (AERODEST), VIA (SIGPOINT) FLIGHT LEVEL (FLNUMBER) (STANDARDDEP) DEPARTURE, SQUAWK (SSRCODE).*

Table 3.4

3.4 Establishing tags for proper nouns and numbers for a single transmission in the written corpus

Phrase	**Appearance in ICAO (2016b)**	**Tag (IN BRACKETS)**
FASTAIR 345 CLEARED TO	*(aircraft call sign)* CLEARED TO (ICAO, 2016b, p. 12.13)	(ACCALLSIGN) CLEARED TO
KENNINGTON	*(aerodrome of destination)* (ICAO, 2016b, p. 12.21)	(AERODEST)
VIA A1	VIA *(route and/or significant points)* (ICAO, 2016b, p. 12.14)	VIA (SIGPOINT)
FL 280	FLIGHT LEVEL *(number)* (ICAO, 2016b, p. 12.13)	FLIGHT LEVEL (FLNUMBER)
WICKEN 3 DELTA DEPARTURE	*(standard departure name and number)* DEPARTURE (ICAO, 2016b, p. 12.16)	(STANDARDDEP) DEPARTURE
SQUAWK 5501	SQUAWKING *(SSR code)* (ICAO, 2016b, p. 12.29) or SQUAWK *(code or IDENT)* (p. 12.34) or SQUAWK *(code)* (p. 12.39)	SQUAWK (SSRCODE)

The written and spoken corpora were tagged. Ten proper nouns were classified into four categories and assigned ten tags. Aviation alphabet letters were assigned a single tag; and numbers were classified into twenty categories with eighteen tags (see Appendix C). The tags allow comparisons across corpora.

3.3.3 Identifying technical vocabulary in aviation radiotelephony

The Heatley et al. (2002) Range programme was used with the BNC/COCA word family lists to establish technical vocabulary. The BNC/COCA word family lists is a set of 29 lists, 25 of which are based on frequency and range data, and four supplementary lists of proper nouns, marginal words, transparent compounds and acronyms (Nation, 2018). Range was used to identify a list of technical aviation words, numbers and acronyms. Several steps were followed to identify words that are technical aviation language:

1. Word types were used as the unit of analysis for the reasons outlined in Chapter 2 (Coxhead, 2017; Ha & Hyland, 2017);
2. The tags developed for comparison above were added to an aviation Baseword list. They represent technical radiotelephony vocabulary and act as content words which convey meaning (Nation, 2016, p. 89). For example, a pilot needs to know numbers for which runway to land on, what altitude to climb to, what gate to use or what should be entered into the altimeter for correct altitude readings (Estival, 2016). Proper nouns provide information about such items as destinations, navigation points or aircraft type. Tagging ensured proper nouns and numbers were retained and counted in the corpora (Nation, 2016);
3. Any words in the corpus, but not in the BNC/COCA lists were analysed to establish if they should be included in the radiotelephony list (Nation, 2016; Nation, Coxhead, et al., 2016; Nation & Kobeleva, 2016; Nation, Shin, et al., 2016). Those that were specific to aviation such as *Straight-in, stop-bar, air-taxi* and air-*taxiing* were added to the radiotelephony list;
4. Other words which occurred in the corpus, but not in the BNC/COCA lists were added to BNC/COCA lists. For example, *co-pilot* consists of *co-* and *pilot. Pilot* can be found in Baseword list 3 and has a commonly understood meaning. *Co-pilot* was added to Baseword list 7 because *co-* is identified by Nation (2016, p. 27) as a level 7 'classical root and affixes' word;
5. Words which appear in BNC/COCA word family lists were examined to determine if they had semantic or structural properties which differed when used in aviation radiotelephony. *Request* is an example of a word that differs from the general English sense for the word, both semantically and grammatically.
    a. The use of *request* in phrases such as *request start-up* from the written corpus was compared to sentences from the website: https://sentence.yourdictionary.com which returned long lists of sentences used to verify the semantic use in general English. In the sentence *request start-up*, request means '*I'm asking you for permission'* which is a slightly altered version of

its general English meaning 'to ask for'. When considered semantically, *request* may be labelled lay-technical (Fraser, 2009) or least technical (Ha & Hyland, 2017).

   b. *Request* is more technical when its syntactic use is considered. The syntax used in aviation radiotelephony communication is an imperative form which did not appear in the sentences from the above website. The form of *request start-up* confirms *request* is technical vocabulary. Other verbs were used in a similar way, such as *report* and *require*;

6. Words which are mentioned in the ICAO documents to be used in a particular way or with a particular meaning were included in the aviation list e.g. *cleared, take-off, break* (GCAA, 2018; ICAO, 2007, 2016a, 2016b);
7. High frequency word types (from the first 1,000 and second 1,000 BNC/COCA lists) were examined if they appeared more than would be expected in general English, since these are likely to be technical vocabulary (Nation, 2013, 2016; Nation & Webb, 2011).For example, *continue, station, expect*;
8. The high frequency words often made up multiword units including: *feet, to, mile, close, appear* (Barshi & Farris, 2013; ICAO, 2016b) e.g. *ALTNUMBER feet, cleared to land, appear up*. In this study, MWUs were treated as 'non-decomposable word-like units' (Nation, 2016, p. xii) and were counted as single words (Nation, Coxhead, et al., 2016; Nation, Shin, et al., 2016). The multiword units were created in the corpora by removing the space between words before analysis e.g. *clearedtoland*.

The nature of technical vocabulary in the aviation radiotelephony simulator emergencies was identified by examining items in the word and number list. Further, technical vocabulary coverage of the spoken corpora was established using the Heatley et al. (2002) Range programme. The nature and coverage of technical vocabulary in this study is presented in Chapter 4. The above steps identified vocabulary as technical (or not) and further analysis, in terms of frequency such as that done in the trades (Coxhead et al., 2020) or in terms of degree of technicality such as that done in a study of academic finance language (Ha & Hyland, 2017) was not done. A larger study is required to establish frequency and degree of technicality of the vocabulary used in aviation radiotelephony.

3.3.4 Keyword analysis for language use

Keywords are those words which occur unusually frequently when a corpus is compared to a reference corpus (Scott & Tribble, 2006). Keywords provide information about how the vocabulary in the study corpus differs from the reference corpus (Scott & Tribble, 2006). Scott and Tribble (2006) use the Shakespeare play *Romeo and Juliet* to examine the information revealed through keyword analysis by using increasingly specialised reference corpora in order to establish how the results change. They examine the play against the following reference corpora: BNC corpus, a corpus of all Shakespeare plays; a corpus of the tragedies alone; and finally, a corpus of the complete works of Shakespeare including poetry. Each of these analyses produced a core list of 26 keywords in the play, but revealed different kinds of information according to the reference list used. Scott and Tribble (2006) and finish by examining a technique developed by Culpeper (2002). Culpeper examined *Romeo and Juliet* using the play itself as the reference corpus to examine the language used by each character. Corpora were created for each character and comparison produced keywords from which Culpeper was able to make inferences about language use by individual characters.

Culpeper's method was used in the keyword analysis in the current research to identify language differences in each of the aerodromes. The reference corpus was the written and spoken corpora combined. The spoken Sandy corpus and the spoken Ghaf corpus were compared individually to the reference corpus to establish language differences between the units. For keyword analysis to work, the reference corpus should be five times larger than the text to be analysed (Scott & Tribble, 2006). Table 3.5 shows that the reference corpus (7439 tokens) is five times the size of the Sandy corpus and 4.25 times as large as the Ghaf corpus. Analysis allowed closer examination of language differences between controllers in each of the units.

Table 3.5

3.5 Size of corpora for keyword analysis

Corpus	Reference Corpus	Ghaf Aerodrome	Sandy Aerodrome	Written corpus
Tokens	7439	1749	1433	4257

The corpora were examined using keyword analysis in Scott (1996) Wordsmith programme. Wordsmith produces a figure for keyness for each of the words identified and the numbers are interpreted as follows:

below 0	not trustworthy
0-2	only worth a bare mention
2-6	positive evidence
6-10	strong
more than 10	very strong (Scott, 2019).

Keyword analysis was used to identify differences in the use of plain language in the two aerodromes and the results are given in Chapter 4.

3.3.5 Interview analysis

The transcribed interviews were analysed initially for interviewee agreement or disagreement with the questions posed. The most relevant themes were then selected for further analysis according to what emerged from the data (Révész, 2012). This process involved reading through the interviews several times and annotating the transcriptions until themes started to emerge. Interview quotes were categorised according to theme. Categories identified were: attitudes towards the use of standard phraseology; beliefs about language use and training; differences between the simulator and the workplace; multicultural context of the workplace and miscommunication; native English speakers' contribution to miscommunication; and clarification of meaning to resolve miscommunication.

3.4 Summary of methodology

The quantitative analyses conducted were used to create an Aviation Radiotelephony Technical Word and Number List of technical aviation vocabulary and multiple word units which served three purposes. First, the technical vocabulary contained in radiotelephony was identified. Second, the list was used to establish the extent to which technical vocabulary was used in the spoken corpora. Third, a keyword analysis identified differences in the use of plain language between Ghaf and Sandy aerodromes. The interviews were analysed for themes which help explain the factors affecting the use of technical vocabulary in the corpora and in the workplace. The results of these analyses are presented in Chapter 4.

Chapter 4 Results

This chapter is divided into three parts which answer each of the research questions in this study. The first research question is answered by examining the Radiotelephony Technical Word and Number List. The second research question is answered by establishing the coverage of technical vocabulary in the spoken corpora of aviation radiotelephony in air traffic control emergency simulator training. The third research question is answered using keyword analysis of the spoken corpora and themes derived from the interview data to examine three factors that influence the use of technical vocabulary in speaking.

4.1 RQ: What is the technical vocabulary of aviation radiotelephony in emergency training in the simulator?

The Aviation Radiotelephony Word and Number List (ARWNL) totalled 577 items and showed that there was a range of technical vocabulary used in emergency training. In addition to the 10 proper noun categories, 18 number categories and aviation alphabet category identified through tagging (totalling 29 tags), the ARWNL contains 548 items including: 301-word types; and 247 multiword units (MWUs). A total of 243 items representing 42% of the list appeared once. A high percentage of single items is not unusual since the BNC corpus includes 40% of them (Scott & Tribble, 2006). The single items were retained in the wordlist for two reasons. First, they met the criteria for technical vocabulary. Second, a bigger study is needed to verify their frequency. In the list, 79 proper nouns, numbers, aviation alphabet and word types and 11 MWUs occurred ten or more times. Given the size of the combined corpora (including non-technical words) in Table 4.1, (900 items) a frequency of ten or more makes these items very high frequency in comparison to the corpora size (Nation, Coxhead, et al., 2016). Column 2 of Table 4.1 shows the number of items, identified as word types in the range programme, in the tagged corpora after completion of steps 1 to 3 in the identification of technical vocabulary (see Section 3.3.3). The final column in Table 4.1 gives the number of items after words had been added to BNC/COCA word lists and items from the word lists were added to the technical word and number list. Further, the final column includes MWUs. The identification of MWUs increased the number of items identified by the Range programme from 667 to 900, suggesting that the language used is more complex once MWUs are taken into account.

Finally, the 577 technical items in the list represents 64% of the 900 items in the combined corpora results.

Table 4.1

4.1 Technical and non-technical vocabulary in corpora

	Number of items in tagged corpora using BNC/COCA word family lists	**Number of items in tagged corpora using adapted BNC/COCA word family lists - includes multiword units**
Written corpus	415	434
Ghaf Aerodrome	296	363
Sandy Aerodrome	286	341
Combined corpora	667	900

Table 4.2 is the first 25 items in the list (see Appendix D for more list items). The table is organised by total frequency (in the final column) and gives the definition of each item and its frequency in each corpus e.g. the item with the highest frequency was *ACCALLSIGN* which is a tag for aircraft callsign, appears in all three corpora and has a total frequency of 676. Table 4.2 represents a range of vocabulary which are identified in the subsections below. Note that the table is organised by frequency in the final column. Further technical vocabulary items can be found in Appendix D which contains items appearing more than 10 times; items appearing more than three times in more than one corpus; items appearing more than 4 times in the written corpus; and multiword units that appear 3 or more times.

Table 4.2

4.2 First 25 word and number types in the Aviation Radiotelephony Word and Number List

Rank	Type	Definition of tags	Written	Ghaf Aero	Sandy Aero	Total Freq
1	ACCALLSIGN	Aircraft callsign	462	160	54	676
2	VECALLSIGN	Vehicle callsign	63	26	94	183
3	AVALPHABET	Aviation alphabet	84	26	43	153
4	UNCALLSIGN	Unit callsign e.g. *Ghaf* or *Sandy*	81	32	18	131
5	TOWER	Type of controller; or building	53	9	62	124
6	TO	Never use before a number	88	10	24	122
7	NNUMBER	Number	52	38	24	114
8	GROUND	Type of controller	29	52	0	81
9	ROGER	All of last transmission received (ICAO, 2016a, 2016b)	36	12	26	74
10	ACTYPE	Type of aircraft e.g. Boeing, Cessna	55	9	8	72
11	RUNWAY		32	6	15	53
12	VIA		49	2	2	53
13	ALTNUMBER	Altitude number e.g. 3 000 feet	47	3	0	50
14	FEET	Distance (horizontal or vertical) e.g. altitude 3 000 feet	48	2	0	50
15	REQUEST		49	1	0	50
16	QNH	Barometric pressure at sea level (Estival & Farris, 2016)	49	0	0	49
17	QNUMBER	QNH number	49	0	0	49
18	REPORT		40	1	0	41
19	TAXIWAY	Road for aircraft to move around aerodrome	30	4	5	39
20	WIND		29	3	1	33
21	MAYDAY	Emergency call	22	7	3	32
22	POSQUEUE	Position in queue	19	12	1	32
23	WINUMBER	Wind number (degrees)	29	3	0	32
24	WISPEED	Number for wind speed (knots)	29	3	0	32
25	KNOTS	Measure of wind speed	31	1	0	30

4.1.1 Proper nouns and semantic categories

There are four proper noun categories in the first 25 items of the technical list. In Table 4.2, three out of the first four items are proper nouns, which are callsigns used to identify who is speaking and who they are speaking to. They are the tags: *ACCALLSIGN, VECALLSIGN,* and *UNCALLSIGN.* Item 10 in the table, *ACTYPE,* is also a proper noun tag for types of aircraft.

Proper noun tags represent a group of items with a particular meaning in aviation. The tags act in a similar fashion to headwords in word families (Nation, 2016; Nation & Webb, 2011). In Table 4.2, the tag *ACTYPE* (aircraft type) shows a total frequency of 72. Examples of individual aircraft types are not included in the technical list. If they were, they would appear as they do in Figure 4.1 which shows the 12 aircraft types found in the written corpus. Aircraft types are common to a particular aerodrome or airport and different types to those listed were found at Sandy and Ghaf aerodromes.

Figure 4.1

4.1 A selection of aircraft types belonging to the proper noun category aircraft type (ACTYPE)

ACTYPE

- Boeing 737
- Boeing 747
- Boeing 767
- Boeing 777
- B747
- B737
- B757
- C172
- Cherokee
- Airbus A320
- Learjet
- Seneca

4.1.2 Numbers and semantic categories

Six out of the first 25 items in the technical vocabulary list in Table 4.2 are numbers with the tags: *NNUMBER, ALTNUMBER, QNUMBER, POSQUEUE, WINUMBER* and *WISPEED.* Each tag is a number category with a specific meaning and format. The first tag, *NNUMBER*, retains numbers in the corpus which would be used as a layperson might understand them e.g.

Gate 2 would be *Gate NNUMBER*. *NNUMBER* is included as technical vocabulary because of the standard operating procedures related to its use. In the case of a gate number, for example, a controller might need to know which aircraft type can park at a particular gate or how an aircraft should be directed to get there. Appendix C shows that numbers may appear in a variety of formats such as four-digit numbers for a radar code or numbers including a decimal point for radio frequencies.

A key point here is that the same numbers can be semantically different. Two examples are the tags *WINUMBER* and *HDGNUMBER* which have a total frequency of 32 and 11 in the list. Both sets of numbers are degrees, but wind is the direction from which wind comes while a heading is the direction an aircraft goes towards. Figure 4.2 identifies some of the numbers from the written corpus which were found under each tag.

Figure 4.2

4.2 A selection of numbers represented by the number categories HDGNUMBER and WINUMBER

HDGNUMBER	WINUMBER
090 160 190 270 280 360	080 190 250 260 270 290 360

4.1.3 Alphabet letters

The final tag category in the corpora was *AVALPHABET*. This category includes the twenty-six letters of the aviation alphabet shown in Figure 4.3. The aviation alphabet letters were used in the corpora to identify taxiways. They can also be used as part of callsigns or as part of navigation points on aeronautical charts. These uses were already accounted for in the proper noun tags.

Figure 4.3

4.3 Aviation alphabet letters represented by the tag AVALPHABET

AVALPHABET	
Alpha Bravo Charlie Delta Echo Foxtrot Golf Hotel India Juliet Kilo Lima Mike	November Oscar Papa Quebec Romeo Sierra Tango Uniform Victor Whisky Xray Yankee Zulu

4.1.4 Acronyms

Acronyms were another category of technical vocabulary identified in the corpora. The only one in Table 4.2 is QNH which is the barometric pressure at sea level (Estival, 2016). Pilots use the QNH number to set their instruments correctly so that they fly at the right level. *QNH* and *QNUMBER* were used in the simulator exercises, but before *mayday* or *pan-pan* which signalled the beginning of the emergencies. Another acronym found in the written corpus (twice) and Ghaf aerodrome corpus (nine times) was POB (persons on board), but no others appeared more than ten times in this study. Other acronyms that occurred in the list were: *FOD, RVR, ATIS, IFR, VFR, ILS, CAVOK* and *QDM.*

4.1.5 Word types and semantic categories

Word types, including purely technical vocabulary and cryptotechnical vocabulary constitute the final category of technical vocabulary in the word and number list. Words such as *feet* and *stand* are single word types because family members such as *foot* or *stands* did not appear in the corpora (Coxhead & Demecheleer, 2018). Words with a purely technical meaning include *taxiway* (Item 19 in Table 4.2), *standby, stopbar, airtaxi, liftoff* and *dewpoint.* Of these words, only *taxiway* and *standby* occurred more than ten times in the list. The proper nouns, numbers, aviation alphabet and acronyms discussed above constitute the remainder of the purely technical vocabulary. Cryptotechnical vocabulary (Fraser, 2009) includes *tower* (item 5, Table 4.2), *to* (item 6, Table 4.2), *ground* (item 8, Table 4.2), *roger* (item 9, Table 4.2) and *runway* (item 10, Table 4.2); *caution* (Baseword List 4), *turbulence* (Baseword List 5), *vacate* (Baseword List 8), *overcast* (Baseword List 10), *mayday* (Baseword List 14) and *wilco* (Baseword List 24). These items were all added to the technical word and number list. Some cryptotechnical words have more than one technical meaning including *apron, approach, base* and *tower* which are discussed below. Fraser (2009) suggests that some words have both a technical meaning and are used in the usual sense e.g. *to.* The word *to* is included here because its use is mandated by the General Civil Aviation Authority in the UAE, which states that, 'in all messages relating to a climb or descent to an ALTITUDE, the word 'to' shall be used immediately prior to the word ALTITUDE' (GCAA, 2018, p. 29 capitals in original). It is also used in its general sense *towards a location.*

Some words could be categorised into different groups but they were recorded as a single word type in the technical list for analysis in the Range programme (Heatley et al., 2002). For example, the word *apron* can be an aerodrome location and a type of controller. *Approach* is used to mean a type of controller and is part of the final flightpath for aircraft approaching the runway. It can also be used in its general English sense. There are other words for which semantic and grammatical differences exist such as *base, tower* and *final*. Categorising words into groups would be useful but is not possible since each word can appear in the list once.

4.1.6 Multiple Word Units: ICAO standard phraseology, subsidiary phraseology, and local phraseology

This section examines the multiword units (MWUs) in the technical list. The multiword units include standard (ICAO), subsidiary, and local phraseology. Table 4.3 contains a list of the eleven MWUs which occurred more than ten times in the technical list. Note the table is organised by total frequency in the last column.

Table 4.3

4.3 Technical multiword units which occur > 10 times in the list

	Written	Ghaf	Sandy	Freq
RUNWAY RWYDES	159	8	7	174
CLEARED TO LAND	16	3	7	26
CLEARED FOR TAKEOFF	24	2	0	26
IN SIGHT	18	1	1	20
HOLDING POINT	18	3	0	21
HOLD SHORT *(of)*	11	3	5	19
REPORT BASE	1	11	0	12
DO YOU HAVE ANY QUESTION	0	11	0	11
ENGINE START APPROVED	0	10	0	10
CONTROL ZONE	10	0	0	10
HOLDING SHORT	10	0	0	10

ICAO standard phraseology was used in the spoken corpora and the written corpus is composed of standard phraseology. Table 4.3 shows that six MWUs occurred ten or more times in the written and at least one spoken corpus. These were: *RUNWAY RWYDES* (rwydes is the runway number e.g. *02, 18*)*, CLEARED TO LAND, CLEARED FOR TAKEOFF, IN SIGHT, HOLDING POINT, HOLD SHORT* and *REPORT BASE.* Another MWU which occurred 17 times in the corpora was *touch and go*. Ten of those occurrences were in the phrase *cleared (for) touch and go* which occurred in the written corpus as *cleared touch and go* and as *cleared for touch and go* in the Ghaf aerodrome spoken corpus. This is essentially the same MWU since it is only separated using the word *for* (see Appendix D, Table D.4). Also, two items appear only in the written corpus: *holding short* and *control zone*. Examination of the spoken corpora scripts suggests that aircraft and vehicles responded to controller instructions with *hold short* rather than *holding short* as appears in the written corpus. It is likely that *control zone* did not appear in the spoken corpus because it was not required for the simulator exercises.

Subsidiary phraseology was found in the Ghaf corpus, and consisted of MWUs specific to the aerodrome. As stated in Chapter 2, subsidiary phraseology is developed for a standard operating procedure (SOP) for which there is no ICAO phraseology and can be constituted of plain language (ICAO, 2007). For example, *Do you have any question* in Ghaf corpus in Table

4.3 is subsidiary phraseology. It was developed at Ghaf aerodrome for a situation for which there is no existing standard phraseology and forms part of an SOP.

Local phraseology was also found in the Ghaf corpus and is made up of MWUs that replace a technical word(s) from the written documents. The phrase *engine start approved* replaces the standard phraseology *start-up approved* in the written corpus. Another example is MWUs with the word *close. Close* appeared in the spoken corpora 11 times in the MWUs *requesting right close* or *right close approved* (see Appendix D, Table D.4). The word *close* is used in American standard phraseology and means *circuit* in ICAO standard phraseology (Boschen & Jones, 2004).

A number of air traffic control events did not occur in the spoken corpora. The following tags and acronyms appeared only in the written corpus: tags were *CONAME, AERODEST, STANDARDDEP, SPROUTE, SSRCODE, QNUMBER, HDGNUMBER, READNUMBER,* and *DPNUMBER*; acronyms were *QNH, RVR, ATIS, CAVOK* and *VASIS*. This finding indicates that a number of areas of air traffic control were not covered after emergencies were declared such as: informing pilots about runway conditions, visibility, and providing pilots with a number so they could be identified on radar; or were not relevant such as company name *(coname)* which is applicable to commercial airports rather than military aerodromes. The language use also reflects the nature of the exercises conducted in the simulator which is discussed in Section 4.3.1.

4.2 RQ: To what extent is technical vocabulary used in radiotelephony in emergency training in the simulator?

The technical vocabulary coverage found for the written corpus was understated. Table 4.4 shows that it was composed of 67.74% technical vocabulary, however this corpus is entirely composed of ICAO standard phraseology, so theoretically is 100% technical language. As previously stated, some air traffic control events were not covered in the simulator, so MWUs not required for comparison with the spoken corpora were not identified. This meant words which would have been part of MWUs remained in the adapted BNC/COCA wordlist or as single word types in the technical vocabulary list. The frequencies of many function words in the 1st 1000 words of the adapted BNC/COCA were high for the written corpus e.g. *at* (32), *of* (27), *the* (24), *on* (24), *for* (20), *and* (19), *from* (17). These function words are likely to be part of the unidentified MWUs which would increase the technical vocabulary coverage in the written corpus.

Table 4.4

4.4 Technical vocabulary coverage in the written and spoken corpora

Adapted BNC/COCA – word frequency level	Types %		
	Written corpus	**Ghaf Aerodrome**	**Sandy Aerodrome**
Technical vocabulary	67.74	70.52	51.61

Technical vocabulary made up a significant proportion of each of the spoken corpora. Table 4.4 shows that technical vocabulary was 70.52% and 51.61% of the spoken communication in Ghaf aerodrome and Sandy aerodrome corpora respectively. In this study, knowledge of the technical vocabulary is essential to successful communication in emergency exercises in the simulator.

4.3 RQ: What factors influence the use of technical vocabulary in speaking?

The Sandy controller used 18.91% less technical vocabulary than the Ghaf controllers. This section examines reasons for why there is a difference in technical language use between the controllers.

Table 4.5 identifies the aerodromes and airports in this study and the controllers who work there. Quotes from their interviews are included in the results sections below.

Table 4.5

4.5 Workplaces of controllers interviewed

Workplace	**Controller Name**
Ghaf Aerodrome	Mohammed, Nelson, Mansour, Alia, Mariam, Shaikha
Sandy Aerodrome	Floyd
Dune Airport	Axel
Desert Airport	Oliver

4.3.1 The exercises and purpose of the simulator training sessions

4.3.1.1 The effect of emergency exercises on language

The emergency exercises in each aerodrome differed. The Sandy aerodrome controller worked on his own as a tower controller. The first emergency was a birdstrike just after take-off which caused an engine fire. The aircraft immediately returned to the field. There were two other aircraft, but they remained on the ground throughout the emergency. There were six different vehicles involved in the emergency including a fire engine, tow truck and vehicles required for cleanup. The second emergency involved a pilot becoming incapacitated just after take-off which resulted in the aircraft returning to the aerodrome to land. Three helicopters were all cleared to land after the emergency was declared. Vehicles involved in the emergency were a fire engine and an ambulance. In contrast, there were two controllers for the Ghaf aerodrome, a tower controller and a ground controller. The first emergency was an aircraft with smoke in the cabin which requested priority landing. Three other aircraft were included in the exercise. All three requested engine startup, then a clearance to fly to designated areas. The aircraft were cleared to start their engines but remained on the ground for the remainder of the exercise. There were three vehicles including a fire engine and two ambulances (for the five people on board the emergency aircraft). In the second emergency an aircraft had an engine flameout and immediately returned to the aerodrome to land. There were two further aircraft in the exercise, one requested start-up and a clearance for flight and the other was a helicopter awaiting take-off. A fire engine was the only vehicle, but there were interactions with an emergency base as well. The final emergency was brake failure of an aircraft that had just landed and needed to stop on a taxiway. There were six other aircraft in the exercise. Three of them were in the air and each one interacted with the tower controller several times. Each aircraft was completing circuits around the aerodrome and requested a low pass, a touch and go, and circuits. The controller required them to report their position at various places in their circuits. The remaining aircraft were on the ground waiting for departure and two were eventually cleared for take-off. There was a fire engine and ambulance in the exercise as well as interactions with the emergency base.

The differences in the type of exercises in each aerodrome had an impact on the technical language used. These differences can be seen in the frequencies for *ACCALLSIGN* and *VECALLSIGN* in Table 4.2. At Ghaf, aircraft callsigns were used 160 times versus 54 times at Sandy. Conversely, vehicle callsigns were used 26 times at Ghaf versus 94 times at Sandy. The impact of the single tower controller at Sandy versus the tower and ground controllers at Ghaf is reflected in the frequencies of the words *TOWER* and *GROUND.* Notably, the word *ground* was not used in the Sandy corpus at all. In Table 4.2, the words *ALTNUMBER, FEET, WINUMBER, WISPEED* and *KNOTS* occur because of pilot requests for flight to designated areas above or below a given height. In response, the controller gave the wind direction *(WINUMBER)* and speed *(WISPEED).* Table 4.3 shows that aircraft were cleared for take-off twice at Ghaf aerodrome, and not at all at Sandy aerodrome. This language use shows that there were differences in the exercises themselves, but these differences do not entirely account for the lower coverage of technical vocabulary for the Sandy controller since one type of technical vocabulary is largely exchanged for another. Examination of the purpose of exercises may only partially explain the differences in coverage.

4.3.1.2 The purpose of the training sessions

Controllers in both Sandy and Ghaf aerodromes stated that the overall purpose of training was to reduce panic, but this purpose was achieved differently. For Ghaf controllers, the simulator training was designed to reduce communication problems during emergencies by standardising the language and procedures. The controllers used a written script with the checklists in the simulator, and practised reading the script to ask pilots for information and pass it on to emergency services, as Mohammed explains,

> [The] emergency situations … today, we tried to do as … standard as much as we can, like asking for questions, POB, fuel endurance, type of emergency. …. We have a checklist, but a lot of people don’t follow it, so you will do it your way, I’ll do it my way (Mohammed).

Once the controllers finished their training, the emergency service personnel would also receive training which was expected to improve communication in emergencies. Two controllers explain,

> we're going to get all the [emergency services] … and we're going to train them as well so that they know how we're going to start reading it and I think that this will cut down on a lot of confusion (Nelson).

> The other agency which is the fire department, the clinic, … [if] everybody's using the same checklist exactly there will be no issue, inshallah (Mohammed).

In contrast, the Sandy simulator session focussed on logistics. The controller practised what to do in an emergency including where to send emergency vehicles. In his interview, Floyd commented on the value of checklists in emergencies. He says,

> we have checklists because … if I didn't have a checklist in front of me, I'd forget something … because if you're … reading off the checklist, it doesn't matter if you get the phraseology correct, just, you know, 'do you have any hazardous cargo on board?' '… do you have any special requests?' … At that point you're just reading … and hopefully you're writing it down legibly (Floyd, Sandy Aerodrome).

Floyd's comment suggests that following a checklist is automatic and the language is a natural product of the process. However, examination of the recorded simulator transcript show that he did not ask pilots questions about hazardous cargo or special requests nor did he pass the information to emergency services. This is partly because the aircraft in both his exercises, had just taken off. Before take-off, the number of persons on board (POB) was established. Since the data used for analysis was after the emergency was declared, the transmissions about POB were not part of the corpus. Another reason for using less technical vocabulary may have been the limitations of the simulator which meant that Floyd had conversations "off-air", about where he could send emergency vehicles, creating a possible distraction. The language left out is the language the Ghaf air traffic controllers practised. The Ghaf controllers focussed on standardising the language and consequently used more technical language. Different training goals contributed to language differences.

4.3.2 Language choices controllers make

4.3.2.1 Use of plain language in the simulator

A keyword analysis identified greater use of plain language by the Sandy aerodrome controller. Table 4.6 shows that *the, can* and *you* were important keywords used by him. No plain language keywords were found for Ghaf aerodrome. The numbers in brackets next to the word *can* show that it appeared 26 times in the Sandy corpus, makes up 1.81% of the corpus and is a very strong keyword at 31.11 keyness. Chapter 3 identified a keyness number of 10 or more as very strong. Table 4.6 shows that *can* appeared in the Ghaf corpus once and not at all in the written corpus.

Table 4.6

4.6 Use of plain language by the Sandy aerodrome controller

Keyword	Sandy Aerodrome – keyword	Appearance in keyword Reference corpus	Appearance in Ghaf Aerodrome	Appearance in written corpus
Can	26, 1.81%, 31.11	27, 0.36%	1, 0.06%	0
You	42, 2.93%, 29.51	71, 0.95%	18, 1.03%	11, 0.26%
The	90, 6.28%, 65.13	151, 2.03%	35, 2%	26, 0.61%

Due to constraints of space, 12 occurrences of the word *can* were analysed in comparison to phrases with the same meaning in the Ghaf and written corpora. In Ghaf Aerodrome, *can* appeared in the following phrase: *We can cancel the emergency* which was an instruction to emergency vehicles. Table 4.7 shows that language use differs between Ghaf and Sandy aerodromes.

Table 4.7

4.7 Comparison of language used in the Sandy, Ghaf and written corpora

Sandy Aerodrome 'can' phrases	**Meaning**	**Ghaf Aerodrome**	**Written Corpus**
you can proceed *(on the runway)//(to)* (4)	Used to tell vehicles to go to an aerodrome location	Proceed to	Proceed (to)//(via)
you can go to (1)	go to	Proceed to	Proceed (to)//(via)
You can proceed as requested (1)	Gives vehicle driver permission to carry out what they requested	proceed back to station approved	Proceed (to)//(via)
you can hold short for the moment (1)	Stop before an identified place e.g. runway	Hold short of *(runway RWYDES)//(RWYDES)*	Hold short (of) runway RWYDES
you can hold your position (1)	Stop where you are	n/a	Hold position *(reason)*
you can follow (1)	Follow	Confirm pilots request to follow him inside the runway	Follow *(aircraft type)*
you can land (1)	Instruction to an aircraft to land	Cleared to land	Cleared to land
you can taxi (1)	Used with aircraft, move around the aerodrome using taxiways	Taxi for holding point Taxi to … via …	Taxi to … via … Taxi to … Taxi via …
you can expect *(to remain on the ground)* (1)	Expect	Expect little delay	Expect (one minute) delay

The Sandy aerodrome controller precedes technical vocabulary with *you can.* For example, in the first row of column 1, the controller says *you can proceed (on/to)* which is *proceed to* in the Ghaf corpus (column 2) and the written corpus (column 3). The pattern *you can* + *technical vocabulary* is repeated in all twelve uses of *can* by the Sandy controller. One of the Ghaf controllers uses a largely plain language construction once in Table 4.7: where the

Sandy aerodrome controller says *you can follow,* one of the Ghaf controllers says *confirm pilot's request to follow him inside the runway.* This statement combines technical vocabulary *(confirm, request, runway)* with plain language.

4.3.2.3 Attitudes towards the use of standard phraseology

The interview data revealed that controllers have different attitudes about the use of standard phraseology. Comments from two controllers show how they approach communication when standard phraseology is not sufficient,

> standard RT [radiotelephony] doesn't cover all the situations so there are always some kind of deviations from the standard RT because the situation requires to act a little bit more differently (Oliver).
>
> I learned on the job so I become … Like for one year I spend 1 year just for training this phraseology, how to speak, how to understand, how to get down some of these things, until … I create my own procedure. My own words. I can use it, but within the standard. So I have to start with the standard, but using my own words (Mansour).

These controllers treat standard phraseology as a language which is adapted to different situations.

This view contrasts with Floyd who sees standard phraseology as a set of phrases to be used in certain circumstances beyond which plain language or general English is used. He states,

> There's no phraseology built for hydraulic failure and you know, the pilot needing an odd request … there's no set phraseology (Floyd).
>
> in other situations um yeah definitely no phraseology, just get the information you need, talk to the pilot like a human being right (Floyd).

Floyd reiterated the point that you should '*just talk to the pilot'* four more times in his interview. The implication is that plain or general English is used when there is no standard phraseology.

4.3.2.4 Beliefs about language use and training for emergencies

The controllers' held differing beliefs about language training for, and language use in, emergencies. Two controllers shared similar beliefs about language use. They stated that controllers should be silent during emergencies since the pilot is busy in the cockpit and should not be disturbed. They also felt that the language could not be practised since there is no standard phraseology and plain language is used. Their views are summed up in the following quotes,

> during emergencies, more plain language [is] used. There's no standard (Axel).
>
> anything that's non-standard, can't teach that (Floyd).

Axel and Floyd thought that a controller who had achieved ICAO English language proficiency Level 4 would know what to say in an emergency. While the remaining seven controllers agreed that English language proficiency is necessary, they had a different opinion about training in that they believed that language training for emergencies would be useful. Shaikha sums up,

> [Training] will help us in our realistic work so we can understand pilots from different nationalities (Shaikha).

Language training for emergencies gives trainees a chance to consider the language they might need. As Mansour puts it,

> Uum sometimes in the simulator they create something like an abnormal, then you have to create your language, you know, you have to like digging inside your mind to put the words (Mansour).

This group of controllers felt that language training would give them an opportunity to identify language they might use in the workplace before they needed it.

4.3.2.5 How the simulator differs from the workplace

The controllers stated that the simulator is quite different to their work in real life. They identified differences including the slower pace of the simulator; and that simulator pilots have good standard phraseology and English language proficiency. Since the simulator pilots' language skill is high, the controllers know what the pilots will say and rarely need to clarify meaning. The simulator represents a best-case scenario in which all participants have the language skills for the task. The next section examines the environmental factors that affect language use in air traffic control.

4.3.3 Environmental factors that influence the use of technical vocabulary in the workplace

4.3.3.1 Multicultural context and miscommunication

Pilots and controllers in the UAE come from diverse backgrounds and have different approaches to communication. At Ghaf aerodrome and both civil airports, pilots came from countries such as: Russia, Egypt, Australia, France, America, China, India and England.

Controllers gave three reasons for miscommunication. The first reason was the low language ability of some pilots. Some Arabic speaking controllers said they resorted to their native language for safety reasons in some instances. The second reason was difficulty in understanding the many different accents of the pilots. While there is no doubt that these factors have a significant impact on miscommunication (discussed in Section 4.3.3.3), they are beyond the scope of this research and will not be investigated. The final reason was the differences in the language use of native English speakers (NES) and non-native English speakers (NNES) and this point is explained more below.

4.3.3.2 Native English speaker contributions to miscommunication

In the interviews, differences in language use between native English speakers (NES) and non-native English speakers (NNES) were considered important. Three themes presented themselves in the data. First, the controllers thought that NNES use more standard phraseology for three reasons. They use a narrower range of words, more phraseology and are better at radio communication than NES. They explain,

> non-English speakers tend to stick to specific words and phrases (Nelson).
>
> When it comes to the non-native I would say that … they might be more keener to stick to the standard RT [radiotelephony] (Oliver).
>
> my experience is that … [if you have] English as second language you speak it better on the radio compared to mother tongues (Axel).

Second, in contrast to non-native speakers, native English speakers use more slang, complex grammar, different vocabulary, speak quickly and use more general/plain English. They say,

> Um and one of the problems that I see native English speakers having is they tend to fall back on slang and words that are not … phraseology (Nelson).

> that's the danger I think … when a native speaker uses too complex … sentence structures (Oliver).

> so they use their own like aviation English back in Australia, so when they come here, they say the words they use … which … we don't understand (Mohammed).

> Some of them [speak faster] yes. Usually because they are flying, they don't have time (Alia).

> The native speaker, they speak in a … mother tongue with a dialect (Axel).

> They've been using more plain language and less of the standard phraseology (Oliver).

Third, the greater use of plain language causes miscomprehension. For example, Nelson and Oliver say,

> if I'm using a slang word … and English is their second language they may not understand it or they may take it as something … totally different because in English the same word could have two different meanings (Nelson).

> when the native speaker he uses really complex language ah the comprehension might be off (Oliver).

In summary, the findings suggest that NNES tend to use more technical language while NES are more likely to use complex or wordy language. These differences in language use can lead to miscommunication. When this happens, the controllers need to clarify meaning to resolve the situation quickly.

4.3.3.3 Clarification of meaning to resolve miscommunication

Clarification of meaning is common in these workplaces. Two themes emerged from the interviews about how meaning is clarified. First, the controllers need to ask the pilots to repeat their request, as Oliver, Mohammed, Alia and Mariam point out,

> I sometimes mirror back the request, can you confirm that I understand it correctly? … (Oliver).

> You should ask him again, say again what you mean (Mohammed).

> Even back with answer that you explain ‘I understand like blah blah blah’ this is what you mean? (Alia).

> I don’t know what he want … and I have to ask him again and again (Mariam).

Second, they ask their colleagues to clarify meaning by asking them what the pilot said, as four controllers explain,

> [new air traffic controllers from the UK] sitting in the seat getting trained and there’s a lot of … ‘what’d he say?’ ‘what’s he asking?’ (Floyd).

> Ask maybe some of our colleagues … what does he mean? So they like explaining. Definitely it’s hard … you know (Mohammed).

> So it’s hard work, but if I stuck on something it will not work. Someone have to take over to understand what they want (Mariam).

> sometimes we have to ask a native speaker English just to tell me what exactly that person has said (Mansour).

In summary, clarification of meaning is sought by asking the pilot to repeat their request or by asking a colleague to explain what the pilot said. The multilingual element of the UAE workplace makes communication challenging in a fast-paced environment and clarification of meaning is a common occurrence.

Miscommunication may be less of an issue in monolingual environments. Oliver comes from Estonia where most of the pilots and controllers speak the same first language. He mentioned the contrast of this environment to his workplace in the UAE,

> we have the same meaning for that word [so] that we understand each other. Let’s say when I work back home, … there is really kind of standard way to use the RT [radiotelephony] or the plain English because the patterns are the same every time (Oliver).

In other words, the pilots and controllers have the same language background which makes it easier to understand each other. Many of the communication issues mentioned in this section are a product of the diverse backgrounds of pilots and controllers. This diversity means they come with different beliefs about the use of technical language in radiotelephony.

4.4 Summary of results

This chapter has presented the findings of this research. It began with a description of the technical vocabulary contained in the Aviation Radiotelephony Word and Number List. The coverage of technical vocabulary in the spoken corpora was established next. Then, the three factors which influence the extent to which technical vocabulary is used by different controllers was explored. The first factor was the nature and purpose of simulator training for emergencies. The second factor was the language choices controllers make based on their attitude towards the use of standard phraseology. Controllers also had differing beliefs about the language used in emergencies, as well as language training for emergencies. The simulator provides an environment quite different from the workplace, so the third factor was the workplace environment in the UAE. Controllers and pilots come from a variety of backgrounds with differing language use which causes miscommunication. Native English speakers contribute to miscommunication when they use difficult vocabulary or complex grammar. Clarification for meaning is a frequent occurrence in the workplace. The significance of these findings is examined in Chapter 5.

Chapter 5 Discussion

This chapter first examines technical vocabulary coverage compared to other professions and shows that radiotelephony language in the simulator is highly specialised. The high coverage confirms that technical vocabulary is an essential component of this language. Second, the Aviation Radiotelephony Word and Number List is applied to two language extracts to show how plain language is used in communication. Finally, a Model of Controllers' Beliefs and Language/Training Outcomes in Aviation Radiotelephony is presented. This model summarises the quantitative and qualitative data from this study to show how controller beliefs affect their language use and underpin beliefs about training.

5.1 Technical vocabulary coverage compared to other professions

Technical vocabulary is a significant proportion of the language used in aviation radiotelephony in emergencies. Chapter 4 showed that coverage was 70.52% and 51.61% of the spoken corpora for Ghaf and Sandy aerodromes respectively. These figures are considerably higher than other professions. The aviation corpora contain five to seven times as much technical vocabulary as the four trades examined in Chapter 2 which confirms that radiotelephony language is highly coded and specialised (Estival & Farris, 2016).

Chapter 2 showed that written corpora contain more technical vocabulary than spoken corpora in previous studies. In the case of each of the trades, the written corpora included more than three times the technical vocabulary of the related spoken corpora. In this aviation study, every second word in the Sandy aerodrome corpus and two words out three for Ghaf aerodrome are technical, yet these figures occur in spoken corpora. This high technical vocabulary coverage explains why radiotelephony communication is unintelligible to native English speakers in a way that other specialist spoken discourse, such as business English, is not (Estival, 2016).

The technical vocabulary coverage is high in aviation radiotelephony because communication is focussed only on the problem to be solved i.e. the emergency. Further, the emergencies in both aerodromes were straightforward with all traffic needing to, and being able to, land normally. Communication with the emergency aircraft was limited to landing clearances, requests for information to be passed to emergency services and requests for the pilot's intention once they landed. Much of this communication was routine in nature and achieved using technical vocabulary and standard, subsidiary or local phraseology. The best-case scenario nature of the simulator may also have increased the coverage of technical vocabulary since all participants used correct standard phraseology. The repetition of routine manoeuvres, such as several non-emergency aircraft carrying out low passes over the runway, in the Ghaf corpus, resulted in a high proportion of routine communication.

5.2 Using the Aviation Radiotelephony Word and Number List to examine the role of plain language

Technical vocabulary is essential in radiotelephony communication. This section examines the elements of the technical language of aviation radiotelephony by focussing on two language extracts. The first extract is taken from the Ghaf corpus in this study and contains a high proportion of technical vocabulary. The second extract is from an ICAO (2010) document where it is presented as an example of plain language in radiotelephony communication. This extract was chosen to provide a contrast to the relatively straightforward situation contained in the simulator extract and to more closely examine the nature of plain language use in a highly complex situation.

In both extracts, MWUs, technical vocabulary and plain language are used to solve a problem. In the first example, the problem is that an aircraft needs to land because an engine has stopped working. In the second, the pilot needs information to make an informed decision about a diversion which may save a passenger's life. The Aviation Radiotelephony Word And Number List was applied to these extracts using the Heatley et al. (2002) Range programme to identify technical vocabulary. The original extracts are shown below, but for analysis, each of the extracts was coded and multiword units were combined. Consequently, the number of types in the analysis differs from what is presented here. The technical vocabulary is in **bold** in each extract. <u>Underlined</u> phrases are those in which technical vocabulary is adapted with the addition of plain language. Phrases which are not underlined consist of mainly plain language. The callsigns have been changed in the Ghaf extract (Extract 5.1) to retain anonymity of the workplace.

5.2.1 An emergency in the simulator

The first extract includes high technical vocabulary coverage and shows how important this vocabulary is to radiotelephony communication in this emergency. Extract 5.1 is divided into 3 columns. The first column identifies the purpose of the communication and the second identifies the speaker e.g. in Turn 1, the pilot informs the air traffic controller about an emergency. The transmission is contained in column 3. Extract 5.1 contains 71 types, 44 technical vocabulary items and 61.97% coverage. MWUs are used in Lines 1 – 8 and 10 - 12 in this emergency. For example, ***runway 27, continue approach, report short final*** are all MWUs which relate to routine Standard Operating Procedures (SOPs) (Mitsutomi & O'Brien, 2003). The communication follows the structure of pilot initial call, controller response and pilot readback found in routine radiotelephony communication (Estival, 2016) in Lines 1 – 3. Controller instruction and pilot readback occurs again in Lines 6-7, and 11-12. Lines 4 and 5 also represent a routine exchange, but in this case, the controller requests information (4) and the pilot provides the information (informs) in Line 5. Even though this dialogue is about an emergency, the first twelve lines contain routine communication composed almost entirely of technical vocabulary. Essential meaning is communicated through multiword units and technical vocabulary.

Extract 5.1

5.1 Extract from Ghaf corpus: Engine flameout emergency

Purpose	Turn no. and speaker	Dialogue
Inform	1 Pilot	**Tower G-ABCD Mayday mayday mayday engine flame out requesting straight-in landing** for **runway 27**
Give instructions	2 Tower (TWR) controller	**G-ABCD. Emergency acknowledged. runway 27. Continue approach. Report short final.**
Read back instruction	3 Pilot	**Report short final. G-ABCD.**
Request information	4 TWR Controller	**G-ABCD when able request total POB fuel on board** and ah any **hazard cargo**
Inform	5 Pilot	Ah **1 POB 2 hours fuel endurance negative hazard cargo G-ABCD**
Give instruction	Line 6 TWR controller	**G-ABCD Roger. Continue approach**
Read back	Line 7 Pilot	**Continue approach. G-ABCD**
Request intention	8 TWR controller	**Request intention** after **landing**
State intention	9 Pilot	I will **advise** once **landed. G-ABCD**
Acknowledge	10 TWR controller	**Roger**
Gives instruction	11 TWR controller	**G-ABCD runway 27 check gear down. Cleared to land**
Read back	12 Pilot	**Cleared to land. G-ABCD**
Request assistance needed	13 Ground (GND) controller	Do you **require** an assist?
Inform	14 Pilot	Ah that's **affirm requesting tow**. We won't be able **to** move **G-ABCD**. We won't be able **to taxi**
Request intentions	15 GND controller	**Copy. Confirm** are you going **to vacate runway** then **stop** for **towing**?
State intentions	16 Pilot	Ah **negative**. We will be **stopping** on the **runway**. **G-ABCD**
Give instruction	17 GND controller	**G-ABCD. Copy**. And advise when the **traffic** totally **stop**
Acknowledge	18 Pilot	**G-ABCD**
Inform	19 Pilot	We are **stop** on the **runway**

Plain language is used with technical vocabulary to clarify a deviation from standard operating procedures. For example, the question in Turn 15: *are you going* ***to vacate runway*** *then* ***stop*** *for* ***towing****?* uses plain language to ask about the pilot's intentions, but the essential meaning is conveyed using technical vocabulary (in bold). The standard procedure is for the pilot to exit the runway and taxi to a parking spot. Turn 15 represents a deviation from the standard procedure clarified with plain language. MWUs are used, along with technical vocabulary with plain language to clarify meaning or 'adapt the phraseology' as the controllers in this study stated in interviews. Plain language is used with technical vocabulary, by the simulator pilot in Turns 9 and 16 to state intentions; and in 14 and 19 to inform. It is used by the controller in Turn 13 to ask what assistance the pilot needs, in Turn 15 to request intentions and in Turn 17 to give an instruction. In each of these turns, there is no standard phraseology available and each phrase represents adapted technical vocabulary.

5.2.2 An emergency involving a critically ill patient

Technical vocabulary is essential even when plain language makes up a greater proportion of communication. A high proportion of plain language can disguise the fact that a request is technical. In contrast to the analysis above, this section examines an extract which is mostly plain language and differs from the previous one because it is a complex emergency. Although M. Barry, an air traffic control instructor, (*personal communication,* August 18, 2020) identified this example as an unusual situation, Eurocontrol (2019) states that an event is an emergency when the safety of an aircraft or someone in the aircraft is endangered for any reason. Since the patient in this example is critically ill, the extract is treated as in an emergency here. Extract 5.2 is taken from ICAO (2010) and is reproduced because it represents language use not found in the corpora in this study, but illustrates how the technical vocabulary word and number list can be applied to clarify the role of technical vocabulary and plain language. The extract contains 82 types of which 17 are technical vocabulary items with 20.73% coverage. Plain language is again used to clarify technical vocabulary, even though the request is more complex than the previous example.

Extract 5.2

5.2 Extract of a military pilot requesting diversion possibilities: Medical emergency

Number & Purpose	Dialogue
Explanation	(A): I have, I have a **request** (1). Our patient is a victim of an *automobile* accident. **Requesting immediate** (2) *orthopaedic* surgery for her severe condition.
Request	(B): Do you know from our **route of flight**, as per our **flight plan** of any **fields** in (name of country) in the event of … that we may **divert** into, where medical crews can meet the **aircraft**,
Explanation	(C): with transportation by **ambulance** and **immediate** transport **to** surgery?
Request	(D): We would like a **request** (3), of names of **fields** along our **route of flight** shortest distance from our **positions** along our continued **route**
Clarification	(E): if you could please ask; (F): we are not **requesting** a **diversion** (4) at this time.
Condition	(G): However if it is **approved** by our controlling **air force** we'll then be **requesting** this **diversion** (5). (H): **How do you copy** sir?

This extract is from ICAO (2010, p. 3.5). It is a single transmission made by a pilot to an air traffic controller. It has been divided into parts here to simplify the discussion.

There are four elements to this communication. The first element is an explanation about why the pilot would like information for a possible diversion contained in parts A and C. The pilot explains why they might need a deviation from standard operating procedures. In this explanation, the line between adapted technical vocabulary and plain language is less clear than in Extract 5.1. The word *to* is highlighted as a technical word but is used in its general sense *(transport **to** surgery)*. The word *request* is used in its general sense in (1), but in (2) *Requesting immediate* uses the structure of standard phraseology. Otherwise, the explanation is plain language which is limited to the problem at hand and clarifies why the diversion might be needed and what would be required should it happen i.e. transport to surgery. However, the words *automobile* and *orthopaedic* raise questions about the scope of the plain language used here. Plain language needs to be limited to the vocabulary which would be understood by aviation personnel who hold ICAO Level 4 language proficiency. In this request, the controller should understand that the patient needs immediate surgery and the kind of surgery required in order to fulfil the request for diversion information. In the language proficiency requirement (LPR) rating scale, Level 4 vocabulary is defined as:

> Vocabulary range and accuracy are usually sufficient to communicate effectively on common, concrete, and work-related topics (1). Can often paraphrase successfully when lacking vocabulary in unusual or unexpected circumstances (2) (ICAO, 2018, p. A.1 numbers added).

The air traffic controller needs to understand the words *automobile* and *orthopaedic*. These words fall outside the first part of the vocabulary LPR (1) above since they are not common, concrete or work-related topics. It also seems that the burden for paraphrasing (part (2) of the LPR) in this case falls on the pilot. These words could be simplified by replacing them with *car* and a description of the medical problem e.g. *broken back/leg*. The explanation in (A) and (C) is to say why the pilot wants a deviation from standard operating procedures.

The second element is a request for information about a diversion. The information required is a list of aerodromes near the pilot's intended flightpath, with an appropriate hospital nearby in parts B and D. Further, the request includes the MWUs *route of flight, flight plan,* and *How do you copy?.* It also includes adapted technical vocabulary (the underlined phrases) to clarify the technical request and plain language for politeness (Lopez, Condamines, & Josselin-Leray, 2013; Moder, 2013) in D *we would like*. Further, it is a technical request since the controller must know how to find this information. Pilots in civil aviation would ask their airlines to provide the information and their contact with air traffic control would be to ask for a diversion. In this case, a military pilot has asked for the information because it is not available through the air force but the controller could request the information from search and rescue in most area control centres (M. Barry, *personal communication,* August 18, 2020).

The third element is clarification about the request for a diversion in parts F and G. The pilot clarifies that this is not a request for a diversion, as such a request is conditional upon approval by the air force. To get approval, the pilot will need to follow procedures which would also apply to a decision to divert. Further, the condition is technical since an aircraft cannot simply divert to another airport as a diversion must be coordinated with air traffic control in other centres. The airports chosen must account for the type of aircraft and be able to accommodate it. The information requested is technical information related to standard operating procedures for diversions, for an appropriate airport and for approval from the air force. The fourth element (E) is a polite phrase recognising the extra workload this request created for the controller (Moder, 2013). It differs from the rest of the transmission because the purpose is to maintain a relationship with the controller (Lopez, Condamines, & Josselin-Leray, 2013; Moder, 2013). While the language in (E) is general English, it serves a narrow and defined purpose in the communication.

Finally, Extract 5.2 is syntactically complex. It is an example of spontaneous language use by a native English speaker (Estival & Molesworth, 2009) which would cause difficulties for aviation personnel with ICAO Level 4 language proficiency. Estival and Molesworth (2009) identify this kind of language use as a reason why highly proficient English speakers should be taught to simplify their language and speak slowly.

5.2.3 Plain language in aviation radiotelephony

In contrast to the complexity of plain language presented in Chapter 2, this study suggests that plain language may be a simplified form of English. ICAO (2007, 2010, 2016a) states that plain language should be clear, concise and unambiguous. As stated in Chapter 2, it is 'constrained by the functions and topics (aviation and non-aviation) that are required by aeronautical radiotelephony communications, as well as by specific safety-critical requirements' (ICAO, 2010, p. 3.5). This study suggests it could also be further limited in two ways. First, it is confined to the language needed to clarify and solve the problem at hand. Second, it should be limited for understanding by all users. All aviation personnel are required to meet the ICAO Level 4 language proficiency standard, so vocabulary should not exceed that requirement. Plain language may include the grammar found in ICAO standard phraseology such as *requesting immediate* but the spontaneous language use found in Extract 5.2 may be beyond ICAO Level 4 language users. Prado (2015) (written in Portuguese) cited in Silva and Tosquil Lucks (2020) showed that the grammatical structures in radiotelephony followed the principles of simplicity and clarity required by ICAO. Plain language should use simplified vocabulary and structures to clarify technical problems or deviations from standard operating procedures. It is combined with technical vocabulary and the amount of plain language used depends on the complexity of the situation rather than what kind of situation it is. A straightforward emergency, such as those examined in this research, require very little plain language (Section 5.2.1). A more complex situation requires more plain language (Section 5.2.2). Ultimately, the assumption that more plain language is used in emergencies (Read & Knoch, 2009) was not supported in this study. Rather, the use of plain language relates to particular situations.

5.3 Miscommunication and controllers' beliefs about standard phraseology

This section explores how variation in beliefs about standard phraseology can cause miscommunication in the workplace. It presents a model of controllers' beliefs about language use in general and in emergencies and the outcomes of those beliefs. The model in Figure 5.1 was developed by combining information from the quantitative and qualitative data. This section gives an overview of the model, then explores the beliefs and consequent outcomes. One belief included in the model was held by all controllers (A), that aviation personnel should have achieved the minimum language proficiency of Level 4 required by ICAO. The model is centred around three belief categories identified in interviews: the role that standard phraseology plays in radiotelephony (B); what constitutes the language used during emergencies (C); and the benefit or otherwise of language training for emergencies (D). The outcomes are organised around two areas. The first is language use (E) in which the composition of the language identified by the controllers in interviews and found in quantitative analysis is summarised. The second is the purpose of emergency training (F) for each of the aerodromes in this study.

Figure 5.1

5.1 A Model of Controllers' Beliefs and Language/Training outcomes in aviation radiotelephony

Beliefs

Meet ICAO minimum levels for English (A)

Basis for radiotelephony (1)	**(B) Standard phraseology**	Limited set of circumstances (7)
Standard phraseology is necessary (2)	**(C) Language use in emergencies**	Use more plain language (8) Must be silent (9)
Beneficial (3) Practise aids successful outcomes (4)	**(D) Language training for emergencies**	No phraseology, so can't train (10) Language proficiency is enough (11)

Outcomes

More technical vocabulary (5)	**(E) Language use**	More plain language (12) Strategies for cooperation (13) May use complex grammar; slang (14)
Language (6)	**(F) Emergency training to practise**	Logistics (15)

Controllers on the left-hand side of the model view standard phraseology as a technical language which forms the basis of radiotelephony communication (1). These controllers treat the language for radiotelephony as a standalone language in which standard phraseology is frequently adapted, using plain language, to circumstances as they arise (Section 5.2.2). Controllers talked about adapting standard phraseology, but it appears they mean adapting the technical vocabulary of standard phraseology to different circumstances. A similar finding was made by Rees (2013) who showed pilots and controllers frequently need to adapt their language in routine situations. The next belief about language use in emergencies is that standard phraseology is necessary (2) and should be used as much as possible. The final beliefs relate to language training for emergencies. From this point of view, language training for emergencies is beneficial (3) because it allows controllers to practise (4) what they will say before an emergency happens and helps to reduce panic in a real emergency. The outcomes of these four beliefs are that controllers are more likely to use more technical vocabulary (5) and the focus of emergency training can be language (6).

On the other hand, the first belief on the righthand side is that standard phraseology is a series of phrases for a finite set of circumstances (7) beyond which it serves no purpose and plain language is used. In terms of emergencies, these controllers believe that more plain language is used (8) and that controllers need to be silent (9) since the pilot is busy in the cockpit and should not be distracted. These controllers believe that language training for emergencies is not possible since there is no phraseology for use in emergencies (10). Also, every emergency is different, so if controllers have sufficient English language proficiency, then they can successfully deal with emergencies (11). The outcomes of these beliefs are, first that more plain language is used (12). Second, that strategies for cooperation are used (13). Keyword analysis showed Floyd used *you can* with standard phraseology as 'a strategy to accomplish cooperative actions effectively' (13) through mitigation (Moder, 2013, p. 259) or as Lopez, Condamines and Josselin-Leray (2013) explain, to courteously convey the authority contained in instructions. Third, language use is more likely to include complex grammar and slang (14). The final outcome is that the purpose of training is logistics (15).

The controllers' language use is not divided according to language background, but according to their beliefs about the role of standard phraseology. Interview data suggests that NNES are more likely to demonstrate the language use (D) shown on the left-hand side (6) and NES are more likely to display outcomes (12) – (14) on the right. Two controllers did follow this pattern. Mansour was one of the NNES controllers whose training session was recorded with language and training outcomes (5) and (6). During interviews he expressed beliefs (1) - (4) on the left-hand side. Floyd's beliefs were in stark contrast to those held by Mansour. Floyd expressed all the beliefs on the righthand side i.e. (7) - (11) with outcomes (12), (13) and (15). Mansour and Floyd's beliefs and outcomes were divergent and represent two distinct paradigms, so provide the basis for the model. Other than Floyd and Mansour, only one other NNES controller, Oliver, held beliefs (1) – (4) with (5 self-reported) as the outcome. The remaining controllers did not all fit neatly into the left-hand side or righthand side of the model. For example, Nelson is a NES, but believes in (1) – (4) with training at (6), and (5) for language use (self-reported). He advocated for greater standardisation of language use in emergencies and generally for all situations. Further, he felt that standard phraseology needed to be emphasised and tested in ab initio training. Axel is a NNES who believes in (1) on the left-hand side, but (8) - (11) about emergencies on the righthand side. The outcomes for him were (15) for training on the righthand side, and (5) for language use (self-reported).

This variation in beliefs can help explain miscommunication. ICAO (2010) gives the example: 'Can we keep high speed?', and explains that 'there is no ICAO phraseology for this pilot's request for permission' (p. 3.6) suggesting that no phraseology means plain language must be used instead. Controllers or pilots who, instead, see standard phraseology as the basis of a technical language might say '**Request maintain speed**' which applies (adapts) the principles and vocabulary of standard phraseology to circumstances for which there is no phraseology (1). The bolded words *request, maintain* and *speed* are technical words in the Aviation Radiotelephony Word and Number List, so the outcome is greater use of technical vocabulary (5). Conversely, 'Can we keep high **speed**?' matches language use in (12) and (13) and follows from the assumption that plain language is used when there is no standard phraseology (7). This short phrase has resulted in very different language use and technical vocabulary coverage (100% versus 20%), depending on the beliefs of a controller.

The assumption that a minimum level of language proficiency by NNES aviation personnel is enough to successfully resolve emergencies (J. Read in Hirch, 2020; ICAO, 2010; Trippe & Baese-Berk, 2019), which is a belief also held by some controllers (8) and (11), did not hold up in this study. This assumption is based on a shared language background (Read & Knoch, 2009; Trippe & Baese-Berk, 2019) rather than a multi-lingual environment like the UAE. The purpose of the Ghaf controllers' simulator training was to address their handling of emergencies which led to confusion. All the controllers had achieved English language proficiency of ICAO Level 4 (the minimum level required for a licensed air traffic controller by ICAO (2018), but their resolution of emergencies varied. Further, in the workplace, the differing language backgrounds of controllers and pilots led to frequent misunderstandings and clarification of meaning (Field, 2020). As noted in Chapter 4, this miscommunication contrasted with Oliver's experience in Estonia where controllers and pilots had a shared understanding of the meaning of words. It appears that the assumptions that underpin ICAO documentation may be flawed.

In summary, the proportion of technical vocabulary used by controllers could be measured and showed differences in its use. Language use may relate more to underlying beliefs about standard phraseology than to NES or NNES language background, although outcomes are more likely to be on the left-hand side for NNES and on the right for NES. Estival and Molesworth (2009) also make this point, suggesting that differences in language background do not influence how well pilots understand air traffic controllers. Rather, the language controllers use is key to understanding. The beliefs identified by the controllers also influence the purpose of emergency training they undergo (language or logistics), which perpetuates their language use and the disparities identified in outcomes, more technical vocabulary or more plain language. One reason for miscommunication in the workplace could be because controllers have differing understandings about the importance of standard phraseology in aviation and how or when plain language should be used, which results in different coverage of technical vocabulary. The division in beliefs shown in Figure 5.1 mirrors the division of assumptions and definitions contained in ICAO documentation.

5.4 Summary of discussion

This chapter identified aviation radiotelephony as a highly technical language in comparison to other professions. It examined the role of plain language and found that it is used to clarify and solve problems. For clear communication, which is understood by all users, plain language should be a simplified version of English. The proportion of plain language required depends on the complexity of the situation rather than the nature of the situation i.e. emergencies do not necessarily result in greater use of plain language as previously assumed.

Differences in the use of technical vocabulary can result in miscommunication for which clarification of meaning (and plain language) is required. Controllers' beliefs about the role of standard phraseology, rather than their language background, influence the extent to which controllers use technical vocabulary. Beliefs about standard phraseology underpin training and perpetuate differences in language use.

What is clear from this discussion, is that aviation radiotelephony communication uses a highly specialised language which needs to be learned and practised by all users. Implications for testing and training are presented in Chapter 6.

Chapter 6 Conclusion

This study set out to identify the language trainee air traffic controllers need to learn and use in emergency training in the simulator. However, once I began to delve into the language my students would need, it became clear that my grasp of the technical language was insufficient to appraise the data I had collected. Further, the small corpora meant I needed to retain all the language collected for analysis, so examining only the plain language would have left very little data. Finally, I could not identify where standard phraseology finished and plain language began. The study was re-designed to identify the technical vocabulary, so that the extent to which it was used (rather than the extent of standard phraseology and plain language) could be established. The findings provided useful information for establishing training and testing needs in the UAE environment. This chapter outlines the focus and contribution of this study, implications for training and testing, limitations, future research and concluding remarks.

6.1 Focus and contribution of this study

An Aviation Radiotelephony Technical Word and Number List was developed. The list clarified the nature of technical vocabulary in radiotelephony in simulator emergencies. It was used to establish the technical vocabulary coverage in spoken corpora which was high compared to spoken and written corpora in other fields. This confirmed that a highly technical language is used in radiotelephony communication and it must be learned by all users. The list also helped clarify the nature of plain language required in a multilingual environment such as the UAE. Plain language should be simplified English. It is combined with technical vocabulary to clarify and solve technical problems related to standard operating procedures. The extent to which plain language is used is according to the complexity of the issue to be resolved rather than to the type of problem. A simple emergency may be resolved using mostly technical language while a more complex one may require more plain language. In either case, radiotelephony is focussed on solving the problem at hand.

Finally, a Model of Controller Beliefs and Outcomes was presented. This model summarised the quantitative and qualitative data in this study to explain the variation in language use found in the corpora and identified in interviews. The most profound diversion in beliefs was on the one hand, controllers who thought that standard phraseology was a standalone language to be adapted to different circumstances. According to the model, these controllers use more technical vocabulary. Conversely, other controllers believe that standard phraseology is for a limited set of circumstances. These controllers will use less technical vocabulary, more plain language and may use slang and complex grammar. These beliefs also underpin training, so training is likely to perpetuate the divergence in language use identified in this study.

6.2 Implications for training

This study shows that language training would be useful to aid standardisation of language use in order to reduce divergent language outcomes. Language practise is useful since it means that a controller has already practised the language for a situation before it arises. A common belief in air traffic control is that it is not possible to provide language training (or testing) for every situation (Farris, 2016a). However, language training provides trainees with tools they can adapt to situations they encounter. This section begins with training needs for ab initio controllers and finishes with experienced controllers from different language backgrounds.

Ab initio controllers would benefit from language training related specifically to radiotelephony regardless of language background. The training would complement simulator training and happen in the classroom to reduce the cognitive load of learning language at the same time as learning how to direct traffic (Drayton & Kelly, 2019). The Aviation Radiotelephony Word and Number List helps identify words or numbers that are difficult to learn or have dual meanings. It also identifies numbers that could cause confusion, not only for the controllers, but for pilots. Hoffman (2020) gives an example of a trainee pilot who mistook a wind direction for a heading (compass direction) and had to be re-directed away from mountains. Air traffic control instructors highlight areas of confusion such as this, but extra practise aids learning and retention. Language extracts like Extract 5.1 from the corpus can be used to provide examples of simulator emergency language use in a similar fashion to Riddiford and Newton (2010) who used authentic workplace dialogues to train learners for communication at work. The corpus can also be used as a basis for task-based language learning which makes the training as close to real interactions as possible (Willis & Willis, 2007).

Experienced controllers would also benefit from language training. For them, the Model of Controller Beliefs and Outcomes provides a useful starting point to re-consider how they use language in radiotelephony. Many authors have suggested that native English speakers should be encouraged to modify their language by paraphrasing based on standard phraseology to accommodate less proficient speakers (Clark, 2017; Moder, 2013; Moder & Halleck, 2009). This language modification would mean that controllers base their language on technical vocabulary or standard phraseology as described by the controllers in this study. That is, treating radiotelephony as a language rather than a division into two arbitrary but difficult-to-distinguish parts (standard phraseology and plain language). Training to achieve a more standardised approach to language would look at scenarios where a high proportion of plain language was used to identify how (if) it could be replaced with technical vocabulary to produce clear and unambiguous communication (GCAA, 2018; ICAO, 2007, 2010, 2016a, 2016b). The scenarios Kim and Elder (2009) and Bieswanger (2013) provide, where wordy language is used, are good examples of language exchanges for this training. Aviation professionals from different backgrounds (native and non-native English speakers) would enrich the discussion in training of this nature. The training would involve practice of scenarios where problem-solving and clarification is needed. For highly proficient English speakers, this practice involves simplifying their language to be understood by less proficient speakers (Clark, 2017; Kim & Elder, 2009; Moder & Halleck, 2009). For others, the purpose of practice is to transition between plain language and technical vocabulary for clarification. This a skill that pilots and controllers identified as essential (Knoch, 2014).

6.3 Implications for testing

Testing ab initio controllers on radiotelephony language is beneficial. The Aviation Radiotelephony Technical Word and Number List provides a basis for diagnostic testing of ab initio controllers' knowledge of the technical vocabulary for aviation radiotelephony. A diagnostic test before they start simulator training would be useful to identify areas of weakness. At the end of their simulator training, ab initio controllers could be required to sit a radiotelephony test of their language skills in emergencies. This test could be based on corpus examples and the word and number list. However, a larger corpus is required for a more representative language sample. Nevertheless, testing would give trainees and instructors useful feedback about their ability with the radiotelephony language.

Testing is essential when language backgrounds differ. Some authors have advocated for language tests and language proficiency requirements which reflect the language controllers (and pilots) use in the workplace (Elder et al., 2017; Kim, 2018; Kim & Elder, 2009, 2015). Dr John Read in Hirch (2020) worked with air traffic controllers to develop a test of radiotelephony language, however he was unable to verify its success. The use of such tests is not widespread and the call for technical language tests is not new. Almost 20 years ago, Verhaegen (2001) argued that aviation personnel should have a proven ability in standard phraseology, implying that they should be tested. Research shows that ability in general English does not translate to success using aviation radiotelephony language (Moder & Halleck, 2009; Trippe, 2018). This current study highlights the highly technical nature of aviation radiotelephony and suggests that it is a reason why a good grasp of general English does not equate to success in radio communication. A test of this highly specialised language is required, for safety reasons, to ensure aviation personnel have the requisite technical knowledge (Kim, 2018) and can use language which could be understood by an ICAO Level 4 speaker (Clark, 2017; Kim & Elder, 2009, 2015; Moder & Halleck, 2009) especially in a multilingual environment like the UAE.

6.4 Limitations

This research did not set out to identify technical vocabulary, so the corpora are smaller than would normally be used for vocabulary research (Nation & Webb, 2011). Further, the small size of this study means the findings are not generalisable. However, small corpora can provide useful information (Gavioli, 2005) which is potentially richer than information from a larger corpus because the researcher is familiar with the context and participants (Vaughan & Clancy, 2013). The addition of manual tags to a small corpus allows the generation of quantitative results (Vaughan & Clancy, 2013). Finally, wordlists can provide quantitative data to make inferences when it is enriched with qualitative information (Vaughan & Clancy, 2013). These advantages of small corpus work enhanced the findings in this study. Second, limiting the focus to emergencies only, meant that some of the recorded data was not included in the sample for analysis. In one case, this meant that technical language which occurred in the written corpus was not part of the spoken corpus because it occurred before the emergency began. Third, the research was carried out in a simulator and not an air traffic control workplace. Consequently, the clarification of meaning identified as important by the controllers is not captured in the corpora. In addition, the coverage of technical vocabulary identified in this study may not represent real-life communication.

6.5 Future research

There are a number of areas for research arising from this work. The first is a vocabulary focussed study which uses a larger corpus. This study could encompass approach and area control communications as well as tower. The data could be used to identify the frequency of technical vocabulary items to determine which are high or low frequency (Coxhead, 2017) and language required to achieve understanding of 98% of spoken interactions (Nation, 2016). The Aviation Radiotelephony Word and Number List could be extended through such a study. A further corpus research project would be to identify the grammar of radiotelephony as has been done in Portuguese (Silva & Tosquil Lucks, 2020).

A useful study would be to examine the specialist aviation field of Human Factors Threat and Error Management (TEM). TEM identifies situations which are a potential threat to safety such as a pilot who reads back correctly, but then proceeds to do something else (ICAO, 2005). These areas are likely to require problem-solving and use more plain language. Such a study would help identify language training needs for controllers.

Research on unusual situations and emergencies which examines the use of technical vocabulary would be useful. A survey and interviews with controllers and pilots about beliefs around using standard phraseology would be useful to determine the veracity of the Model of Controller Beliefs and Language Outcomes, especially if it were coupled with language analysis to identify technical vocabulary coverage by individuals.

It would be useful to work with air traffic control instructors to develop a radiotelephony language training course and test for ab initio controllers. The course could be used to test how well teaching the language separately reduces the cognitive learning load in the simulator (Drayton & Kelly, 2019) and results in better training outcomes. Finally, a test of radiotelephony language could be developed and trialled for use with licensed controllers.

6.6 Concluding remarks

This study is a response to the learning needs of ab initio air traffic control students who would benefit from language training alongside their simulator training. Learning to manage aircraft is a difficult task. Learning a new language at the same time makes it more difficult. The insights gained from this research have afforded me a better understanding of the technical vocabulary required and the areas where students might struggle. This research has given me an insight into why there are language differences in the workplace and an idea of how training can help minimise this divergence and reduce miscommunication. Conversely, the investigation also highlights how training can perpetuate divergent language use in the workplace. From a personal perspective, this research has been insightful and invaluable.

References

Adolphs, S., & Carter, R. (2013). *Spoken Corpus Linguistics : From Monomodal to Multimodal*. Taylor & Francis Group. http://ebookcentral.proquest.com/lib/vuw/detail.action?docID=1251059

Alderson, C. J. (2009). Air safety, language assessment policy, and policy implementation: the case of aviation English. *Annual Review of Applied Linguistics*, *29*, 168-187. https://doi.org/10.1017/S0267190509090138

Alderson, C. J. (2011). The Politics of Aviation English Testing. *Language Assessment Quarterly*, *8*(4), 386-403. https://doi.org/10.1080/15434303.2011.622017

Anthony, L. (2019). *AntConc*. In (Version 3.5.8) Waseda University. https://www.laurenceanthony.net/software/antconc/

Barshi, I., & Farris, C. (2013). *Misunderstandings in ATC Communication : Language, Cognition, and Experimental Methodology*. Routledge. http://ebookcentral.proquest.com/lib/vuw/detail.action?docID=4512291

Bieswanger, M. (2013). Applied linguistics and air traffic control: Focus on language awareness and intercultural communication. In S. Hansen-Schirra & K. Maksymski (Eds.), *Aviation Communication: Between Theory and Practice*. Peter Lang GmbH.

Bieswanger, M. (2016). Aviation English: Two distinct specialised registers? In C. Schubert & C. Sanchez-Stockhammer (Eds.), *Variational Text Linguistics: Revisiting Register in English* (pp. 67-85). De Gruyter, Inc.

Borowska, A. P. (2017). *Avialinguistics: The study of language for aviation purposes*. Peter Lang GmbH.

Boschen, A. C., & Jones, R. K. (2004). Aviation Language Problem: Improving Pilot-Controller Communication. *IEEE*, 291-299.

Bratanić, M., & Anić, A. O. (2010). *Compiling Lexical Information for an Aviation English Dictionary* Reconceptualizing LSP, Aarhus.

Bullock, N. (2015). Wider considerations in teaching speaking of English in the context of aeronautical communications. *IATEFL ESPSIG Journal*, *45*, 4-11.

Bullock, N. (2017). *A re-evaluation of washback for learning and testing language in aeronautical communications* Internation Civil Aviation English Association, Embry-Riddle University. https://commons.erau.edu/icaea-workshop/2017/monday/19

Campbell-Laird, K. (2004). *Aviation English: A review of the language of international civil aviation* International Professional Communication Conference, Minneapolis. http://ieeexplore.ieee.org.helicon.vuw.ac.nz/stamp/stamp.jsp?arnumber=1375306

Chung, T. M., & Nation, P. (2004). Identifying technical vocabulary. *System*, *32*(2), 251-263. https://doi.org/10.1016/j.system.2003.11.008

Clark, B. (2017). *CAP 1375 Aviation English Research Project: Data analysis findings and best practice recommendations* [Independent Research Report].

Cobb, T. (n.d.). *Range for texts*. In https://www.lextutor.ca/cgi-bin/range/texts/

Cookson, S. (2009). Zagreb and Tenerife: Airline accidents involving linguistic factors. *Australian Review of Applied Linguistics*, *32*(3), 22.21-22.14.

Coxhead, A. (2017). *Vocabulary and English for Specific Purposes Research: Quantitative and Qualitative Perspectives* (1 ed.). Routledge. https://doi.org/10.4324/9781315146478

Coxhead, A., & Demecheleer, M. (2018). Investigating the technical vocabulary of Plumbing. *English for Specific Purposes*, *51*, 84-97. https://doi.org/10.1016/j.esp.2018.03.006

Coxhead, A., Demecheleer, M., & McLaughlin, E. (2016). The technical vocabulary of carpentry : loads, lists and bearings. *TESOLANZ Journal*, *24*, 38-71.
Coxhead, A., McLaughlin, E., & Reid, A. (2019). The development and application of a specialised word list: the case of Fabrication. *Journal of Vocational Education & Training*, *71*(2), 175-200. https://doi.org/10.1080/13636820.2018.1471094
Coxhead, A., Parkinson, J., Mackay, J., & McLaughlin, E. (2020). *English for Vocational Purposes: Language Use in Trades Education* (1 ed.). Routledge. https://doi.org/10.4324/9780429449932
Culpeper, J. (2002). *Computers, language and characterisation: An analysis of six characters in Romeo and Juliet* Conversation in Life and Literature: Papers from the ASLA Symposium, Universitetstryckeriet.
Cutting, J. (2012). English for aiport ground staff. *English for Specific Purposes*, *31*(31), 3-13.
Day, B. (2004). Heightened awareness of communication pitfalls can benefit safety. *ICAO Journal*, *59*(1), 20-22.
Delpech, E., Laignelet, M., Pimm, C., Raynal, C., Trzos, M., Arnold, A., & Pronto, D. (2018, May). *A Real-life, French-accented Corpus of Air Traffic Control Communications* Language Resources and Evaluation Conference (LREC), Miyazaki, Japan.
Domogala, P. (1991). What happens if R/T standards start to slide? Fourth International Aviation English Forum: Aviation English Standards, Paris.
Douglas, D. (2014). Nobody seems to speak English here today: Enhancing assessment and training in aviation English. *Iranian Journal of Language Teaching Research*, *2*(2), 1-12.
Drayton, J., & Kelly, M. (2019). *Romeo, Tango, Foxtrot: A task-based approach to meeting the diverse training needs of pilot and air traffic control trainees* International Civil Aviation English Association (2019) Conference, Embry Riddle University, Florida. https://commons.erau.edu/icaea-workshop/2019/proceedings/1/
Duff, P. A. (2012). How to carry out case study research. In A. Mackey & S. M. Gass (Eds.), *Research Methods in Second Language Acquisition: A practical Guide* (First ed., pp. 95-116). Blackwell Publishing Ltd.
Elder, C., McNamara, T., Kim, H., Pill, J., & Sato, T. (2017). Interrogating the construct of communicative competence in language assessment contexts: What the non-language specialist can tell us. *Language and Communication*, *57*, 14-21.
Emery, H. J. (2014). Developments in LSP Testing 30 Years On? The Case of Aviation English. *Language Assessment Quarterly*, *11*(2), 198-215. https://doi.org/10.1080/15434303.2014.894516
Estival, D. (2016). Aviation English: A linguistic description. In D. Estival, C. Farris, & B. Molesworth (Eds.), *Aviation English: A lingua franca for pilots and air traffic controllers* (pp. 22-53). Routledge.
Estival, D., & Farris, C. (2016). Aviation English as a lingua franca. In D. Estival, C. Farris, & B. Molesworth (Eds.), *Aviation English: A Lingua Franca for pilots and air traffic controllers*. Taylor Francis.
Estival, D., & Molesworth, B. (2009). Radio miscommunication: EL2 pilots in the Australian general aviation environment. *Linguistics and the Human Sciences*, *5*(3), 351-378. https://doi.org/0.1558/lhs.v5i3.351
Eurocontrol. (2019, 30 November, 2019). *Emergency or abnormal situation*. Skybrary. Retrieved 7 October, 2020 from https://www.skybrary.aero/index.php/Emergency_or_Abnormal_Situation

Farris, C. (2016a). Aviation language testing. In D. Estival, C. Farris, & B. Molesworth (Eds.), *Aviation English: A lingua franca for pilots and air traffic controllers* (pp. 75-91). Routledge.

Farris, C. (2016b). ICAO language proficiency requirements. In D. Estival, C. Farris, & B. Molesworth (Eds.), *Aviation English: A lingua franca for pilots and air traffic controllers* (pp. 54-74). Routledge.

Farris, C., Trofimovich, P., Segalowitz, N., & Gatbonton, E. (2008). Air traffic control communication in a second language: Implications of cognitive factors for training and assessment. *TESOL Quarterly*, *42*(3), 397-410.

Field, J. (2020, 6 July, 2020). *John Field Presentation: Idle Chatter? A fresh look at what really goes on in tests of interactive speaking*. University of Bedfordshire. Retrieved 27 August from https://www.youtube.com/watch?v=ONM7xcJTPD0&feature=youtu.be

Fraser, S. (2009). Breaking down the divisions between general, academic, and technical vocabulary: The establishment of a single, discipline-based word list for ESP learners. *Hiroshima Studies in Language and Language Education*, *12*, 151-167. https://doi.org/10.1007/978-3-319-70214-8

Friedman, D. (2012). How to collect and analyse qualitative data. In A. Mackey & S. M. Gass (Eds.), *Research Methods in Second Language Acquisition: A practical guide* (1st ed.). Blackwell Publishing Ltd.

Gavioli, L. (2005). *Exploring corpora for ESP learning*. John Benjamins.

GCAA. (2016). *Civil Aviation Regulations: Part 8, Subpart 4*. Author.

GCAA. (2018). *UAE Radiotelephony Standards*. Author.

Green, E. G. H. (1991). *The enforcement of RTF phraseology and aspects of callsign confusion* Fourth International Aviation English Forum: Aviation English Standards, Paris.

Ha, A. Y. H., & Hyland, K. (2017). What is technicality? A technicality analysis model for EAP vocabulary. *Journal of English for Academic Purposes*, *28*, 35-49. https://doi.org/http://dx.doi.org/10.1016/j.jeap.2017.06.003

Hansen-Schirra, S. (2013). Linguistic Dominance in Air Traffic Control. In S. Hansen-Schirra & K. Maksymski (Eds.), *Aviation Communication: Between Theory and Practice* (pp. 83-93). Peter Lang GmbH.

Heatley, A., Nation, P., & Coxhead, A. (2002). *The Range Programme*. In https://www.wgtn.ac.nz/lals/about/staff/paul-nation

Hirch, R. (2020). An Interview with Dr. John Read. *Language Assessment Quarterly*, *17*(2), 204-215. https://doi.org/10.1080/15434303.2020.1730842

Hoffman, T. (2020). *Aviation English, please*. FAA. Retrieved 6 July, 2020 from https://medium.com/faa/aviation-english-please-fb7e86dbbd70?source=friends_link&sk=2a3b974efb0a9c917bafe8ccc8d6524a

Howard, J. W., III (2008). “Tower, am I cleared to land?”: Problematic communication in aviation discourse. *Human Communication Research*, *34*, 370-391.

Huhta, A. (2009). An analysis of the quality of English testing for aviation purposes in Finland. *Australian Review of Applied Linguistics*, *32*(3), 26.21 - 26.14. https://doi.org/https://doi.org/10.2104/aral0926

Hüllen, W. (1981). Movements of Earth and in the air: A study of certain verbs occurring in the language of international pilots. *The ESP Journal*, *1*(2), 141-154.

ICAO. (2005). *Threat and error management in air traffic control* (Preliminary Edition ed.). ICAO.

ICAO. (2007). *Doc 9432: Manual of Radiotelephony*. Author.

ICAO. (2010). *Doc 9835: Manual on the implementation of ICAO language proficiency requirements*. Author.
ICAO. (2016a). *Annex 10: Aeronautical Telecommunications* (7th ed., Vol. Vol. 2 Communication Procedures including those with PANS status). Author.
ICAO. (2016b). *Doc 4444: Procedures for Air Navigation Services: Air Traffic Management*. Author.
ICAO. (2018). *Annex 1: Personnel Licensing 12th Edition*. Author.
Intemann, F. (2008). "Taipei ground, confirm your last transmission was in English..." - An analysis of aviation English as a world language. In C. Gnutzmann & F. Intemann (Eds.), *The Globalisation of English and the English Language Classroom* (2nd ed.). Narr.
Kim, H. (2018). What constitutes professional communication in aviation: Is language proficiency enough for testing purposes? *Language Testing*, *35*(3), 403-426.
Kim, H., & Billington, R. (2018). Pronunciation and comprehension in English as a lingua franca communication: Effect of L1 influence in international aviation communication. *Applied Linguistics*, *39*(2), 135 - 158.
Kim, H., & Elder, C. (2009). Understanding aviation English as a lingua franca. *Australian Review of Applied Linguistics*, *32*(3), 23.21-23.17.
Kim, H., & Elder, C. (2015). Interrogating the construct of aviation English: Feedback from test takers in Korea. *Language Testing*, *32*(2), 129-149.
Knoch, U. (2014). Using subject specialists to validate an ESP rating scale: The case of the International Civil Aviation Organization (ICAO) rating scale. *English for Specific Purposes*, *33*, 77-86.
Koble, S., & Roh, P. (2013). Linguistic characteristics of aviation English and their practical use - an analysis. In S. Hansen-Schirra & K. Maksymski (Eds.), *Aviation communication: Between theory and practice* (pp. 43-53). https://doi.org/10.3726/978-3-653-02048-9
Loewen, S., & Philp, J. (2012). Instructed second language acquisition. In A. Mackey & S. M. Gass (Eds.), *Research Methods in Second Language Acquisition* (pp. 53-73). Blackwell Publishing Ltd.
Lopez, S., Condamines, A., & Josselin-Leray, A. (2013). *An LSP learner corpus to help with English radiotelephony teaching* Twenty years of learner corpus research: Looking back, moving ahead. Corpora and language in use Conference – proceedings 1, Louvain-la-Neuve.
Lopez, S., Condamines, A., Josselin-Leray, A., O'Donoghue, M., & Salmon, R. (2013). Linguistic analysis of English phraseology and plain language in air-ground communication. *Journal of Air Transport Studies*, *4*(1), 44-60.
Mathews, E. (2004). New provisions for English language proficiency are expected to improve aviation safety. *ICAO Journal*, *59*(1), 4-6.
Mell, J. (2004a). Language training and testing in aviation need to focus on job-specific competencies. *ICAO Journal*, *59*(1), 12-14.
Mell, J. (2004b). Training Implications of ICAO (International Civil Aviation Organisation) Language Proficiency Requirements. *IEEE*, 262-265.
Mitsutomi, M., & O'Brien, K. (2003). The critical components of aviation English. *International Journal of Applied Aviation Studies*, *3*(2), 117-129.

Moder, C. L. (2013). Aviation English. In B. Paltridge & S. Starfield (Eds.), *The Handbook of English for Specific Purposes* (pp. 249-263). John Wiley & Sons. https://ebookcentral.proquest.com
Moder, C. L., & Halleck, G. B. (2009). Planes, politics and oral proficiency: testing international air traffic controllers. *Australian Review of Applied Linguistics*, *32*(3), 25.21-25.16.
Nation, P. (2013). *Learning vocabulary in another language* (Second edition. ed.). Cambridge University Press.
Nation, P. (2016). *Making and using wordlists for language learning and testing*. John Benjamin Publishing Company. http://ebookcentral.proquest.com/lib/vuw/detail.action?docID=4673371
Nation, P. (2018). The BNC/COCA word family lists. 1 - 4. https://www.wgtn.ac.nz/__data/assets/pdf_file/0004/1689349/Information-on-the-BNC_COCA-word-family-lists-20180705.pdf
Nation, P. (2020). *The BNC/COCA word family lists*. Victoria University of Wellington. Retrieved 31 July, 2020 from https://www.wgtn.ac.nz/__data/assets/pdf_file/0005/1857641/about-bnc-coca-vocabulary-list.pdf
Nation, P., Coxhead, A., Chung, T. M., & Quero, B. (2016). Specialized word lists. In I. S. P. Nation (Ed.), *Making and Using Word Lists for Language Learning and Teaching* (pp. 145-151). John Benjamins Publishing Company. http://ebookcentral.proquest.com/lib/vuw/detail.action?docID=4673371
Nation, P., & Kobeleva, P. (2016). Proper Nouns. In I. S. P. Nation (Ed.), *Making and Using Word Lists for Language Learning and Testing* (pp. 55-64). John Benjamins Publishing Company. http://ebookcentral.proquest.com/lib/vuw/detail.action?docID=4673371
Nation, P., Shin, D., & Grant, L. (2016). Multiword Units. In I. S. P. Nation (Ed.), *Making and using word lists for language learning and testing* (Vol. 39, pp. 71 - 79). John Benjamins Publishing Company. https://doi.org/10.1093/applin/amx052
Nation, P., & Webb, S. (2011). *Researching and analyzing vocabulary*. Heinle, Cengage Learning.
Pannebecker, A. (2019). An analysis of the most used lexical terms in corpus-based emergency situations. In A. Pacheco (Ed.), *English for aviation: Guidelines for teaching and introductory research*. EDIPUCRS.
Prado, M., & Tosqui-Lucks, P. (2019). Designing the Radiotelephony Plain English Corpus (RTPEC): A specialized spoken English language corpus towards a description of aeronautical communications in non-routine situations. *Research in Corpus Linguistics*, *7*, 113-128. https://doi.org/10.32714/ricl.07.06
Ragan, P. H. (1997). Aviation English: An introduction. *Journal of Aviation/ Aerospace Education and Research*, *7*(2), 25-36. http://commons.erau.edu/jaaer/vol7/iss2/1
Read, J., & Knoch, U. (2009). Clearing the air: Applied linguistic perspectives on aviation communication. *Australian Review of Applied Linguistics*, *32*(3), 21.21-21.11. https://doi.org/10.2104/aral0921
Rees, L. (2013). The role of plain language in English training for French air traffic controllers. In S. Hansen-Schirra & K. Maksymski (Eds.), *Aviation Communication: Between Theory and Practice* (pp. 95-103). Peter Lang GmbH.

Révész, A. (2012). Coding second language data validly and reliably. In A. Mackey & S. M. Gass (Eds.), *Research Methods in Second Language Acquisition: A practical guide* (1st ed.). Blackwell Publishing Ltd.

Riddiford, N., & Newton, J. (2010). *Workplace Talk in Action: An ESOL resource*. Retrieved 28 April, 2019 from https://www.victoria.ac.nz/lals/centres-and-institutes/language-in-the-workplace/resources/teaching-and-learning-resources

Roberts, J. (2018). Identifying and analyzing vocabulary from authentic materials in a content-based ESP class. In E. Friginal (Ed.), *Corpus linguistics for English teachers: New tools, online resources, and classroom activities* (pp. 218-223). Routledge.

Roberts, J., & Orr, A. (2020). Language education for ab initio flight training. In S. K. Kearns, T. J. Mavin, & S. Hodge (Eds.), *Engaging the next generation of aviation professionals: A plan going forward* (pp. 149-162). Routledge.

Roberts, J., Prado, M., & Tosqui Lucks, P. (2019). The development of aviation English programs. In E. Friginal, E. Mathews, & J. Roberts (Eds.), *English in global aviation: Context, research, and pedagogy* (pp. 215-246). Bloomsbury.

Rothwell, W. J., Benscoter, B., King, M., & King, S. (2016). *Mastering the instructional design process: A systemic approach*. John Wiley & Sons Inc.

Sänne, J. M. (1999). *Creating safety in air traffic control*. Arkiv Förlag.

Scott, M. (1996). *Wordsmith Tools*. In Oxford University Press.

Scott, M. (2019). *How key words are calculated*. Retrieved 17 May from https://lexically.net/downloads/version8/HTML/keywords_calculate_info.html?anchor=bic_score

Scott, M., & Tribble, C. (2006). *Textual patterns : Key words and corpus analysis in language education* https://ebookcentral-proquest-com.helicon.vuw.ac.nz

Shawcross, P. (2004). Proficiency requirements underscore importance of teaching and testing. *ICAO Journal*, *59*(1), 18-19.

Shin, D., & Kim, H. (2005). English for Aviation Specific Purposes: Needs Analysis for English Proficiency Requirements. *Korean Journal of the Applied Linguistics*, *21*(2), 193-217.

Silva, A. L. B. d. C. e., & Tosquil Lucks, P. (2020). Around the world in aeronautical and aviation English courses. *CEBETECLE*, *2*(1). https://revista.cbtecle.com.br/index.php/CBTecLE/article/view/274/pdf

Smidl, L., Svec, J., Tihelka, D., Matousek, J., Romportl, J., & Ircing, P. (2019). Air traffic control communication (ATCC) speech corpora and their use for ASR and TTS development.(Report). *Language Resources and Evaluation*, *53*(3), 449. https://doi.org/10.1007/s10579-019-09449-5

Sullivan, P., & Girginer, H. (2002). The use of discourse analysis to enhance ESP teacher knowledge: an example using aviation English. *English for Specific Purposes*, *21*, 397-404.

Tiewtrakul, T., & Fletcher, S. R. (2010). The challenge of regional accents for aviation English language proficiency standards: A study of difficulties in understanding in air traffic control-pilot communications. *Ergonomics: Human Factors in Aviation*, *53*(2), 229-239. https://doi.org/10.1080/00140130903470033

Trippe, J. (2018). *Aviation English is distinct from conversational English: Evidence from prosodic analyses and listening performance* [Doctorate, University of Oregon]. Ann Arbor, Michigan.

Trippe, J., & Baese-Berk, M. (2019). A prosodic profile of American aviation English. *English for Specific Purposes*, *53*, 30-46.

Varantola, K. (1989). Natural language vs. purpose-built languages. The human factor. *Neuphologische Mitteilungen*, *90*(2), 173-183. http://www.jstor.com/stable/43343925
Vaughan, E., & Clancy, B. (2013). Small corpora and pragmatics. In J. Romero-Trillo (Ed.), *Yearbook of Corpus Linguistics and Pragmatics 2013: New Domains and Methodologies* (Vol. 1, pp. 53-73). Springer Netherlands. https://doi.org/10.1007/978-94-007-6250-3
Verhaegen, B. (2001). Safety issues related to language use have come under scrutiny. *ICAO Journal*, *56*(2), 15-17.
Wang, A. (2007). Teaching aviation English in the Chinese context: Developing ESP theory in a non-English speaking country. *English for Specific Purposes*, *26*, 121-128.
Wang, A. (2008). Reassessing the position of Aviation English: from a special language to English for Specific Purposes. *Iberica*, *15*, 151-164.
Willis, D., & Willis, J. (2007). *Doing task-based teaching*. Oxford University Press.
Yan, R. (2007). *Assessing English language proficiency in international aviation: Issues of reliability, validity, and aviation safety* (Publication Number 3261787) [Ph.D., University of Louisiana at Lafayette]. ProQuest Dissertations & Theses Global. Ann Arbor. https://search.proquest.com/docview/304699921?accountid=14782

Appendices

Appendix A

Investigating language used by air traffic controllers in emergencies

A.1 Information sheet for participants

You are invited to take part in this research. Please read this information before deciding whether or not to take part. If you decide to participate, thank you. If you decide not to participate, thank you for considering this request.

Who am I?

My name is Jenny Drayton and I am a Master's student in Applied Linguistics at Victoria University of Wellington. This research project is work towards my thesis.

What is the aim of the project?

This project is to examine the language used by air traffic controllers in emergency training in the simulator to establish training needs in the UAE. Your participation will support this research by providing examples of language used by an air traffic controller to deal with an emergency. This information will be used to develop training material for ab initio controllers. This research has been approved by the Victoria University of Wellington Human Ethics Committee HEC ID 0000027733.

How can you help?

You have been invited to participate because you are involved in emergency continuation training at GAL ANS Training Centre in Al Ain. If you agree to take part, I will record your training session with your permission and write it up later. Only those parts of the recording related to the research will be transcribed.

You are also invited to take part in an interview about your experience as an air traffic controller in the UAE, your thoughts about language use in emergencies, and about language training. The interview will take about twenty minutes. I will audio record the interview with your permission and write it up later. You can choose not to answer any question or stop the interview at any time, without giving a reason. You can withdraw from the study by contacting me at any time before 30th September, 2019. If you withdraw, the information you provided will be destroyed or returned to you.

The recordings will be used for this research. They will **not** be used to make a judgement about the language you use or to decide how well you dealt with the emergencies.

What will happen to the information you give?

Only my supervisor and I will read the notes or transcript of the interview. The interview transcripts, summaries and any recordings will be kept securely and destroyed on 30 August, 2024.

What will the project produce?

The information from my research will be used in my Master's dissertation and/or academic publications and conferences.

If you accept this invitation, what are your rights as a research participant?

You do not have to accept this invitation if you don't want to. If you do decide to participate, you have the right to:

- choose not to answer any question;
- ask for the recorder to be turned off at any time during the interview;
- withdraw from the study before 30 November, 2019;
- ask any questions about the study at any time;
- receive a copy of your training session transcript (only parts relevant to the research will be transcribed) which you can read over and comment on;
- receive a copy of your interview recording;
- receive a copy of your interview transcript which you can read over and comment on;
- be able to read any reports of this research by emailing the researcher to request a copy.

If you have any questions or problems, who can you contact?

If you have any questions, either now or in the future, please feel free to contact either me or my supervisor:

Student:
Name: Jenny Drayton
University email address:
draytojenn@myvuw.ac.nz

Supervisor:
Name: Dr Averil Coxhead
Role: Associate Professor
School: Linguistics and Applied Language Studies
Phone: +64 4 4635625
averil.coxhead@vuw.ac.nz

Human Ethics Committee information

If you have any concerns about the ethical conduct of the research you may contact the Victoria University HEC Convenor: Dr Judith Loveridge. Email hec@vuw.ac.nz or telephone +64-4-463 6028.

Investigating language used by air traffic controllers in emergencies

A.2 Consent to record training session and interview

This consent form will be held for five years until 30 August, 2024.

Researcher: Jenny Drayton, School of Linguistics and Applied Language Studies, Victoria University of Wellington.

- I have read the Information Sheet and the project has been explained to me. My questions have been answered to my satisfaction. I understand that I can ask further questions at any time.
- I agree to:
  - ☐ an audio recording being made of my emergency continuation training session
  - ☐ take part in an audio recorded interview.

I understand that:

- I may withdraw from this study at any point before 30 September, 2019, and any information that I have provided will be returned to me or destroyed.
- The identifiable information I have provided will be destroyed on or before 28 February, 2020.
- Any information I provide will be kept confidential to the researcher, the supervisor and the transcriber.
- I understand that the findings may be used for a Masters dissertation and/or academic publications and/or presented to conferences.
- **I understand that any observation notes and the recordings will be kept confidential to the researcher, the supervisor and the transcriber.**
- My name will not be used in reports and utmost care will be taken not to disclose any information that would identify me.
- I will receive a copy of the transcript of my interview which I can read and comment on.
- I would like a copy of the recording of my interview Yes ☐ No ☐
- I would like a copy of the final transcript of my interview Yes ☐ No ☐
- I would like to receive a summary of the thesis (1 to 2 pages) Yes ☐ No ☐

Signature of participant: ________________________________

Name of participant: ________________________________

Date: ______________

Contact details: ________________________________

Investigating language used by air traffic controllers in emergencies

A.3 Information sheet for GAL ANS training centre

This is a request for permission to conduct research at GAL ANS training centre.

Who am I?

My name is Jennifer Drayton, and as you know, I am a course developer at GAL ANS training centre. I am also a Master's student in Applied Linguistics at Victoria University of Wellington. This research project is work towards my MA thesis.

What is the aim of the project?

The aim of this project is to examine the language used by air traffic controllers in emergency situations in the simulator to establish training needs in the UAE. The recordings of 20 trainees will provide examples of language used by an air traffic controller when dealing with an emergency. This information will be used to develop training material for ab initio controllers. This research has been approved by the Victoria University of Wellington Human Ethics Committee HEC ID 0000027733.

How can you help?

As you know, emergency continuation training is conducted with air traffic controllers at GAL ANS Training Centre in Al Ain. I would like to record training sessions of air traffic controllers who agree to be recorded. I would also like to conduct 20 minute interviews with ten of the participants. The interviews will be done at the training centre and I will transcribe the training sessions and interviews. To do this, I need your permission to carry out this research at the training centre.

What will happen to the information the air traffic controllers give?

Only my supervisor, Associate Professor Averil Coxhead (Victoria University of Wellington) and I will read the transcripts of the recordings and interviews. The interview transcripts, summaries and any recordings will be kept securely and destroyed on 30 August, 2024.

What will the project produce?

The information from my research will be used in my Master's dissertation and/or academic publications and conferences. It may also be used to inform training courses and materials design at the training centre.

If you have any questions or problems, who can you contact?

If you have any questions, either now or in the future, please feel free to contact either me or my supervisor:

Student:
Name: Jenny Drayton
University email address:
draytojenn@myvuw.ac.nz

Supervisor:
Name: Dr Averil Coxhead
Role: Associate Professor
School: Linguistics and Applied Language Studies
Phone: +64 4 4635625
averil.coxhead@vuw.ac.nz

Human Ethics Committee information

If you have any concerns about the ethical conduct of the research you may contact the Victoria University HEC Convenor: Dr Judith Loveridge. Email hec@vuw.ac.nz or telephone +64-4-463 6028.

Investigating language used by air traffic controllers in emergencies

A.4 Consent to record training sessions and interview trainees at GAL ANS training centre

This consent form will be held for five years.

Researcher: Jenny Drayton, School of Linguistics and Applied Language Studies, Victoria University of Wellington.

I have read the Information Sheet and the project has been explained to me. My questions have been answered to my satisfaction. I understand that I can ask further questions at any time. I understand that:

- Data collection will take place between the 23rd of June and the 31st of October, 2019
- Training centre equipment will be used to record sessions
- Participants may withdraw from this study at any point before the interview and any information they have provided will be returned to them or destroyed
- The identifiable material participants provide will be returned to them or destroyed on 28 February, 2020
- Any information provided by participants will be kept confidential between the researcher and the supervisor
- The results will be used for an MA thesis, academic publications and presented to conferences

I agree that:

- the researcher can approach trainees at the GAL ANS Training Centre to record emergency training sessions and interview trainees
- GAL ANS training Centre can be identified in reports on this research
- I have the authority to agree to this on behalf of the organisation.

- I would like to receive a summary of the thesis (1 to 2 pages) Yes ☐ No ☐

Signature of Manager: ________________________________

Name of Manager: ________________________________

Date: ______________

Contact details: ________________________________

Investigating language used by air traffic controllers in emergencies

A.5 Protocol for recruitment of research participants

Thank you for agreeing to assist me in recruiting participants for my master's research.

This is an outline for approaching possible research participants.

Eligibility

Anybody who is at the training centre to do Emergency Continuation Training (ECT) is eligible to participate.

Recruitment

1. Explain that you are speaking to them on behalf of your colleague who is conducting research for a master's degree from Victoria University in New Zealand. The research is about the language that air traffic controllers use in emergencies. Explain that participation is voluntary and if they would prefer not to be involved, that is no problem (if they indicate at this point that they do not want to participate, please thank them for their time).

2. Explain that any information gathered will be confidential and only the researcher and supervisor will see it. It will not be shared with GAL ANS staff members or management. It will not be used to judge their performance in the training session or their English language ability, but will be used for research purposes only.

3. If they are interested, provide the information sheet. If they are not interested, thank them for their time.

4. Once they have read the sheet, let them indicate if they would like to be involved or not or if they have further questions.

5. Remind them that participation is voluntary and answer any questions they have. If they indicate that they would prefer not to participate, please thank them for their time.

6. If they are willing to participate, please make sure they complete all sections of the form. If they do not want to be interviewed, they should tick only the first box which agrees to their training session being recorded. They may tick either or both boxes.

7. If they are not willing to participate, please thank them for their time.

Thank you

The following script may be used:

"Good morning / afternoon"

"I am approaching you on behalf of my colleague Jenny Drayton who is conducting research for a master's degree from Victoria University in New Zealand. The research is about the language that air traffic controllers use in emergencies. Participation is voluntary and if you would prefer not to be involved, that is no problem" (if they indicate at this point that they do not want to participate, please thank them for their time).

"Any information gathered will be confidential and only Jenny and her research supervisor will see it. It will not be shared with GAL ANS staff members or management. It will not be used to judge your performance in the training session or your English language ability."

If they are interested, provide the information sheet. If they are not interested, thank them for their time.

Once they have read the sheet, let them indicate if they would like to be involved or not or if they have further questions.

"As I said before, participation is voluntary. Do you have any questions?"

Answer any questions they have. If they indicate that they would prefer not to participate, please thank them for their time.

If they are willing to participate, please make sure they complete all sections of the consent form. If they do not want to be interviewed, they should tick only the first box which agrees to their training session being recorded. They may tick the first box or both boxes.

"Could you please complete this consent form which gives permission for the training session to be recorded. Also, if you are happy to be interviewed afterwards, please tick both boxes. Thank you very much for your participation."

If they are not willing to participate, please thank them for their time.

Appendix B Interview questions

Thank you for agreeing to take part in this interview. It will take about 20 minutes. I'll record this interview, but remember you can ask me to turn off the recorder at any time. Let's start by talking about your language background.

1. What languages do you speak and how often do you use them?

Now I'd like to ask about your work experience.

2. How many years have you worked as an air traffic controller?
3. How many years have you worked in the UAE?
4. Where have you worked before?
5. You speak to pilots every day in your job. How does this part of your job compare to when you speak to pilots in the simulator?

I'd like to ask you about your opinions on language training for air traffic controllers.

6. Would it help trainee air traffic controllers to learn phraseology as a separate subject (outside of the simulator)? Why/Why not?
7. Did you receive training (outside the simulator) in phraseology or English language when you trained to be an air traffic controller? Was it helpful?
8. Would you say that the language used on the radio by native English speakers and non-native English speakers is the same or different? (if different) In what ways?
9. Do you think it would be useful to give communication or language training to all air traffic controllers? Why/Why not?

10. Would language training help in emergency situations? What kinds of language training would you suggest?

Appendix C Tags for identification of technical vocabulary

Table C.1

Proper nouns

Tag	**Item representation in Doc 4444 and definition**	**Replaced in written corpus (examples)**
	Identification	
Callsigns	Callsigns identify who is speaking and who is spoken to in an air traffic control conversation.	
(UNCALLSIGN)	*(unit call sign)* – name of the location of air traffic control unit providing air traffic control (ICAO, 2016a) e.g. Heathrow. It is followed by the type of air traffic control service being provided (ICAO, 2016a) e.g. Heathrow tower or Heathrow approach.	Georgetown (tower), Alexander (approach), Georgetown (ground)
(VECALLSIGN)	Vehicle callsigns – not identified in Doc 4444, but appear in ICAO (2007) and GCAA (2018).	Trucker 5, Worker 21
Aircraft		
(CONAME)	*(company name)* – Ownership of an aircraft	Fastair
(ACTYPE)	*(aircraft type)*	Boeing 737, Boeing 747, Boeing 767, Boeing 777, C172, Cherokee, Airbus A320, Learjet, Seneca

Destination, place or navigation point		
(DESPLACE)	*(place)* - Places which are part of a clearance, position report or emergency report and can be found on an aeronautical chart (Estival, 2016)	Kennington, Ghantoot, Jebel Ali Palms, Sharjah, Sharjah University
Departure or Route		
(SPROUTE)	ROUTE *(name, number or code)*	Route Echo

Note: The following proper noun tags were included in Table 3.4 and have not been repeated here: (ACCALLSIGN), (AERODEST), (SIGPOINT) and (STANDARDDEP).

Table C.2

Number tags

Tag	Item representation in Doc 4444 and definition	Replaced in corpus (examples)
	3 to 5-digit numbers – Altitude	
(ALTNUMBER)	*(number)* preceded by the word ALTITUDE	800, 600, 10 000, 7 000 followed by FEET
	4-digit numbers	
	QNH, QFE or altitude followed by a number	
(QNUMBER)	QNH or QFE *(number)* air pressure required for accurate height or altitude readings (ICAO, 2016a).	1003, 1012, 1013, 1022, 1009, 1010, 1019, 1008, 1001, 1003, 1014, 1018
	24-hour time	
(TIMEHOUR)	TIME *(number)* MINUTES; TIME *(time); (time)*	0611, 1732, 0715 and a half
	3-digit numbers	
	Wind direction	
(WINUMBER)	*(number)* – in the phrase, WIND *(number)* DEGREES	290, 260, 270, 250, 080, 370, 190, 360, 260, 250, 180, 340, 350, 070
	Heading	
(HDGNUMBER)	HEADING *(three digits)* - Headings are measured in degrees and usually preceded by the word heading.	090, 270, 190, 160, 360 and 280

QDM		
(HDGNUMBER)	QDM precedes a magnetic heading	Not listed in Doc 4444, but included as QDM in ICAO (2007) and GCAA (2018)
2-digit numbers		
Runway number		
(RWYDES)	*(number)* in the phrase, RUNWAY *(number)* – runway direction is given as a 2-digit number	12, 24, 30, 14, 06, 09, 31, 27, 25, 02, 20, 16, 17, 32, xx
Time in minutes		
(TIMEMIN)	*(number)* or *(time)* in the following phrases: TIME *(number)* MINUTES; TIME *(time); (time)*	47, 35, 49, 27, two three and a half
1 or 2-digit numbers		
Wind Speed		
(WISPEED)	*(number)* in the phrase: WIND *(number)* knots, and gives the speed of the wind in knots	4, 5, 7, 8, 10, 18, 20, 22, 25
Temperature		
(TENUMBER)	*(number)* in the phrase: TEMPERATURE [MINUS] *(number)* – air temperature	25, 7 and minus 2
Dewpoint temperature		
(DPNUMBER)	*(number)* in the phrase: DEWPOINT [MINUS] *(number),* which can, but does not always, follow temperature.	minus 3

Single digit numbers		
Readability Scale		
(READNUMBER)	Not listed in Doc 4444, but included in ICAO (2007) and GCAA (2018) - Identifies how well the listener can hear the speaker from unreadable 1 through to 5	three and five
Queue position		
(POSQUEUE)	NUMBER in the phrase: NUMBER ... FOLLOW *(aircraft type and position)* - Aircraft are sometimes given a position in a queue as number 1, 2 to come in to land for example	1, 2
Stand, hangar, gate, helipad		
(NNUMBER)	*(number)* in e.g. STAND *(number)*	37, 17, 24
Taxiway or Runway Intersection		
(NNUMBER) - where a number is included	*(identification of taxiway); (taxiway); RUNWAY (or TAXIWAY) (number):* Intersections or taxiways usually include an aviation alphabet letter and sometimes include a number	
Radio Frequency		
(NUMFREQ)	*(frequency)* The word FREQUENCY is also used in the corpus	129.1

Other		
POB (Persons on Board)		
(NNUMBER)	Not listed in Doc 4444, but included in ICAO (2007) and GCAA (2018).	
Horizontal Distance		
(DISTNUMBER)	*(distance) (units)*	Visibility 8 and 20 km; distance from the end of the runway 3, 4, 5,6, 10 and 15 miles; distances along the runway 32, 600, 650, 700 and 1000 metres; snow on runway edge 30 cm.

Note: The following number tags were included in Table 3.4 and are not repeated here: (FLNUMBER), (SSRcode).

Appendix D Aviation Radiotelephony Technical Word and Number List

Table D.1

Aviation Word and Number List: Types appearing 10 or more times in list

	TYPE	ICAO/GCAA	Ghaf Aero	Sandy Aero	FREQ
26	DEGREES	31	0	0	31
27	**DISTNUMBER** *(horizontal or vertical distance)*	29	0	0	29
28	RIGHT	27	1	0	28
29	VACATED	27	0	0	27
30	TRAFFIC	24	2	0	26
31	WILCO	19	1	5	25
32	STAND	24	0	1	25
33	DOWNWIND	25	0	0	25
34	NUMBER	19	5	0	24
35	TAXI	23	1	0	24
36	FINAL	22	0	1	23
37	**NUMFREQ** *(radio frequency)*	21	1	0	22
38	LANDING	18	3	0	21
39	AIRCRAFT	3	4	13	20
40	**SIGPOINT** *(significant point)*	20	0	0	20
41	FIRE	2	7	10	19
42	PROCEED	15	0	4	19
43	LEFT	17	1	0	18
44	CROSS	16	0	1	17
45	COPY	1	12	3	16
46	COPIED	6	3	6	15
47	READY	11	3	1	15

48	BELOW	15	0	0	15
49	MILES	15	0	0	15
50	STARTUP	15	0	0	15
51	**RWYDES** *(runway number)*	1	13	0	14
52	BASE	8	5	1	14
53	TIMEMIN	12	2	0	14
54	STOP	11	3	0	14
55	FOLLOW	9	1	3	13
56	JOIN	12	0	1	13
57	APPROVED	13	0	0	13
58	DEPARTURE	13	0	0	13
59	TEMPERATURE	4	8	0	12
60	STANDBY	7	5	0	12
61	TOW	8	0	4	12
62	PANPAN	9	3	0	12
63	BEHIND	11	0	1	12
64	DUE	12	0	0	12
65	TAKEOFF	12	0	0	12
66	NEGATIVE	2	9	0	11
67	POB	2	9	0	11
68	**TENUMBER** *(temperature number)*	3	8	0	11
69	VACATE	10	1	0	11
70	CONTINUE	11	0	0	11
71	GATE	11	0	0	11
72	**HDGNUMBER** *(heading number)*	11	0	0	11
73	IMMEDIATELY	11	0	0	11
74	INFORMATION	11	0	0	11
75	CONFIRM	0	10	0	10

76	**DESPLACE** *(designated place)*	8	2	0	10
77	POSITION	9	0	1	10
78	HEADING	10	0	0	10
79	TURN	10	0	0	10

Table D.2

Types appearing more than three times in more than one corpus

TYPE	ICAO/GCAA	Ghaf Aero	Sandy Aero	FREQ
AMBULANCE	1	7	1	9
CROSSING	8	0	1	9
EMERGENCY	3	3	3	9
STOPPING	6	3	0	9
AFFIRM	2	2	4	8
HOLD	6	0	2	8
ENGINE	6	0	1	7
MAKE	6	0	1	7
AHEAD	4	0	2	6
EXPECT	5	0	1	6
TIMEHOUR	4	0	2	6
VACATING	5	1	0	6
ALTITUDE	4	1	0	5
CALLSIGN	3	2	0	5
CHECK	0	5	0	5
PASSING	4	0	1	5
RETURN	4	1	0	5
UP	1	0	4	5
ATTENTION	1	3	0	4
CALL	3	0	1	4
DOWN	0	1	3	4
ENTER	3	1	0	4
HELIPAD	0	1	3	4
WAITING	1	2	1	4

Table D.3

Types appearing > 4 times in written corpus

TYPE	**ICAO/GCAA**
APRON	9
CAUTION	9
CONTACT	9
IMMEDIATE	9
LINEUP	9
METRES	9
NORTH	8
AIRBORNE	7
CANCEL	7
CLEARANCE	7
MAINTENANCE	7
VFR	7
APPROACH	6
BACKTRACK	6
CLEARED	6
HANGAR	6
PUSHBACK	6
RIGHTHAND	6
STOPBAR	6
SSRCODE	6
AERODEST	5

Table D.4

Multiword Units: Aircraft in the air

TYPE	ICAO/GCAA	Ghaf Aero	Sandy Aero	FREQ
(cleared for) LOW APPROACH	3	3	0	6
CONTINUE APPROACH	0	3	0	3
((cleared (for)) TOUCH AND GO	4	9	0	13
ON THE GO	0	5	0	5
GO AROUND	2	3	0	5
GOING AROUND	4	0	0	4
REQUESTING RIGHT CLOSE	0	4	0	4
RIGHT CLOSE APPROVED	0	5	0	5
REPORT RIGHT BASE	0	5	0	5
AT NUMBER	0	6	0	6
GEAR DOWN	0	3	1	4
APPEAR DOWN	4	0	0	4
APPEARS UP	4	0	0	4

Table D.5

Ground, aircraft and vehicles

TYPE	ICAO/GCAA	Ghaf Aero	Sandy Aero	FREQ
VIA TAXIWAY	0	1	4	5
ENTERING RUNWAY	0	0	4	4

Table D.6

Ground, Aircraft only

TYPE	ICAO/GCAA	Ghaf Aero	Sandy Aero	FREQ
LINEUP AND WAIT	3	1	0	4
LINING UP	3	1	0	4

Table D.7

Ground, vehicles only

TYPE	ICAO/GCAA	Ghaf Aero	Sandy Aero	FREQ
PROCEEDING *(to)*	4	6	4	14
PROCEED *(on (onto))* THE RUNWAY	0	1	4	5
ON FREQUENCY	0	6	3	9
GO AHEAD	0	6	1	7
STANDBY POSITION	0	3	4	7

Table D.8

Other

TYPE	ICAO/GCAA	Ghaf Aero	Sandy Aero	FREQ
(I) SAY AGAIN	7	5	0	12
BEHIND *(the) (aircraft)*	0	2	2	4
STANDING BY	0	4	2	6
BE ADVISED	0	2	5	7
GOOD COPY	0	2	4	6
WIND CALM	0	0	3	3
CLEARED TO	2	1	0	3

Table D.9

Emergency subsidiary phraseology, Ghaf Aerodrome

TYPE	**Ghaf Aero**
FULL EMERGENCY	5
NATURE OF EMERGENCY	4
BASE OPERATION	3
MAIN FIRE	3
THIS IS THE TOWER	3
BRAKE FAILURE	6