Australian Government
Civil Aviation Safety Authority

Safety behaviours: human factors for pilots 4th edition

Resource booklet 4 Communication

ISBN: 978-1-76137-069-4 (Print)
ISBN: 978-1-76137-070-0 (PDF)

Note: References are contained in brackets and can be found at the end of the document.

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Regardless of whether you are a single-pilot operation or fly for a large organisation, effective communication is a critical part of your flying operations. Misunderstandings and communication failures cost time and money, and at worst, compromise safety, as some of the case studies in this booklet show.

Clear communication can be the difference between safe flight and aircraft accidents. A communication misunderstanding, for example, was a key causal factor in the Tenerife accident which caused the greatest loss of life in aviation to date, 583 people.

'The single biggest problem in communication is the illusion that it has taken place.'

George Bernard Shaw, Irish dramatist

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Introduction

We often think communication is easy. After all, we do it all the time. But everyday communication is not as simple as it may seem, and there is room for us all to improve our communication skills.

Communication has been defined as the 'imparting or exchanging of information by speaking, writing or using some other medium'.[1]

More simply, it can be defined as achieving shared meaning.

Communication is a dynamic and irreversible process by which we engage with others and interpret messages within a given situation or context. Everyday mediums of communication include speech, looks, gestures, writing (printed and electronic – text, email etc) and images/visual.

Pilots need to be able to communicate effectively on the ground and in the air with a variety of people, including other pilots, passengers, refuellers, aircraft maintenance engineers and air traffic controllers.

Accuracy in how you send, receive and interpret information is vital. What makes sense to one person can be distorted or misinterpreted by another regardless of whether it's written, verbal/oral or non-verbal.

To be effective, communication requires 5 elements to work together:

1. The individual sending the message must present it clearly, with the necessary detail, and should have credibility.
2. The person receiving the message must be prepared to, and decide to, listen; ask
3. questions if they don't understand something; and trust the person sending the message.
4. The delivery method chosen must suit the circumstances and needs of both sender and receiver.
5. The content of the message must resonate and connect, on some level, with the already-held beliefs of the receiver.

Given the combination of elements required, it is no wonder that there is often miscommunication. You may pay little attention to a message you receive from someone you don't respect.

Conversely, if there is a steep authority gradient in the cockpit (see booklet 5 Teamwork), a crew member with lesser authority may be reluctant to speak up, either because they do not wish to question the authority of someone they respect, or for fear of being ignored or belittled.

Active listening involves the listener giving non-verbal and sometimes verbal feedback to the speaker. This indicates to the speaker that the listener is making a conscious effort to understand. In the cockpit, an active listener would acknowledge what was being said, ask questions if unsure, and then undertake the action being requested.

When communication fails

Dr Dominique Estival, a Western Sydney University linguist, pilot and flight instructor who published a book in 2016 called Aviation English: A lingua franca for pilots and air traffic controllers, cited miscommunication as contributing to the deaths of more than 2,000 people in aircraft accidents since the mid-1970s.

Dr Estival warned that some common terms have been misunderstood over the years, with fatal consequences. She has urged native English speakers to adjust their communication in the aviation industry to reduce the risk of misunderstanding by pilots who have English as their second language.[2]

The following examples of miscommunication range from the amusing to the tragic, but underline how prevalent communication failures are, and that if we are to be effective communicators, we need to work on our communication and refining our skills.

Plain language matters

The following anecdote, quoted in the UK Civil Aviation Authority's publication (CAP 719) about the importance of 'plain talk' and communicating information clearly, has been around for a while, but it does highlight the safety implications of poor communication:[3]

Due to the high cost of aviation gasoline, a private pilot once wrote to his aviation administration and asked if he could mix kerosene in his aircraft fuel. He received the following reply:

Utilisation of kerosene involves major uncertainties/probabilities respecting shaft output and metal longevity where application pertains to aeronautical internal combustion power plants.

The pilot sent the following response:

Thanks for the information. Will start using kerosene next week.

The pilot then received the following urgent message:

Regrettably decision involves uncertainties. Kerosene utilisation consequences questionable, with respect to metalliferous components and power production.

This prompted the pilot to reply:

Thanks again. It will sure cut my fuel bill.

That same day he finally received a clear message:

DON'T USE KEROSENE. IT COULD KILL THE ENGINE – AND YOU TOO!

The following incident, reported by the Australian Transport Safety Bureau (ATSB), saw an aircraft substantially damaged. Fortunately, the pilot was able to walk away.[4]

Incorrect records lead to fuel exhaustion

On the morning of 15 June 2017, the pilot of a Beech 58, VH-PBU, contacted a refueller at Mount Isa Airport, Queensland and requested 400 litres of fuel. The refueller added 200 litres but recorded the amount as 400 litres.

At the end of the day, the refueller totalled the daily fuel delivery quantities and detected a 200-litre discrepancy between the recorded deliveries and the meter readings.

The refueller identified the cause of the discrepancy and immediately went out to the aircraft, but could not locate the pilot. The refueller was then distracted by a phone call and forgot about the error.

On the morning of 26 June 2017, another pilot prepared for a ferry flight in the aircraft from Burketown to Normanton. At about 0815 Eastern Standard Time, the aircraft, with only the pilot on board, departed Burketown.

About 5 nm north of Normanton, both engines failed. The pilot made a forced landing in a paddock. While the pilot was not injured the aircraft was substantially damaged.

The ATSB said the incident underlined the importance of communication once an error has been discovered. The refuelling error was discovered 11 days before the incident, but this was not communicated to the operator or pilots. Knowledge of the error would have enabled the pilots to correct the fuel log and avoid the incident.

image: Damage to right wing of VH-PBU following accident © Queensland Police Service

Sago Mine Disaster, West Virginia

After an explosion at the Sago Mine in West Virginia in 2006, and a subsequent collapse, 13 miners were trapped for nearly 2 days.[5]

Some 41 hours after the explosion, the mine rescue command centre received a report from rescue crews that 12 missing miners had been found alive.

Rescue workers and family members were jubilant. The media celebrated the news that 12 of the trapped men had survived and the 'miracle survival' appeared on the cover of many newspapers.

But in the next edition, jubilation would turn to shock and sadness.

About 4 hours after the first announcement, a representative of the mine's owner said that there had been a 'miscommunication' and that the 12 men had been found dead; only 1 had survived.

The mix-up was blamed on the fact that the rescue crews had made their report while wearing breathing apparatus. This had made it difficult to understand their message, which was they had found 12 men and were checking them for vital signs.

The message was taken to mean the men were alive and was passed on without checking.

It was, perhaps, a case of people hearing what they were hoping to hear, and in this sense, had some parallels with the Tenerife aviation disaster, discussed later in this booklet.

Mistranslation of vital information

A Norwegian student staying in Copenhagen, Denmark ended up in an emergency department after he was smashed over the head with a glass during a bar fight.[6]

The student tried to explain to the medical staff that he suffered from haemophilia, a condition impairing the body's ability to control blood clotting. This was important information, given that the student's head was bleeding profusely.

Unfortunately, there was an issue with translation of the word 'haemophilia' from Norwegian to Danish. The doctor thought the student was saying he was a 'homofil', meaning he was gay, told him that nothing was wrong and sent him home.

Sadly, the student was found dead 2 days later because of blood loss due to the lack of blood clotting.

Atomic bomb translation misunderstanding

It has been argued that a mistranslation of a message towards the end of World War II precipitated the use of atomic bombs on the Japanese cities of Hiroshima and Nagasaki by the United States.[6]

In response to a message sent before the bombs were dropped, asking if Japan would surrender, the Japanese ruler used the word *mokusatsu*.

In Japanese, the word means we *withhold comment – pending discussion*, but when the response was sent to Washington, the word was mistranslated to mean *we are treating your message with contempt*.

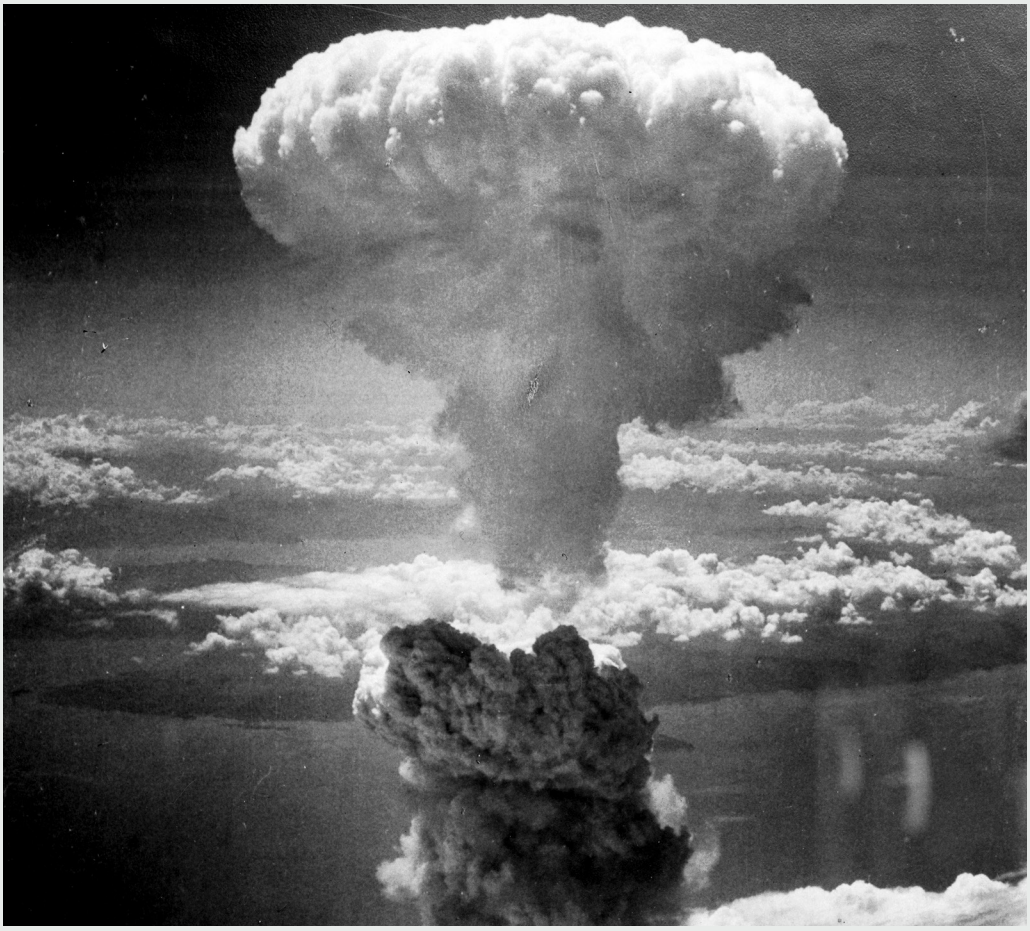


Image taken by Charles Levy, U.S. National Archives and Records Administration | Mushroom cloud above Nagasaki after atomic bombing on August 9, 1945. Taken from the north west.

Information transfer problems

In many cases, poor communication in aviation arises because the person with necessary information does not understand the need to pass it on, or does so inaccurately.[7]

This was highlighted in an aircraft accident involving Avianca Flight 052, a Boeing 707B which ran out of fuel over Long Island en-route to John F. Kennedy International Airport (JFK) in New York.[8]

The Spanish speaking flight crew failed to convey critical information about their fuel status and emergency to air traffic control. The crew used phrases such as *we need priority* and *we're running out of fuel* instead of declaring an emergency and using standard English phraseologies. The accident resulted in 8 of the 9 crew members, and 65 of the 149 passengers on board, being killed.

Owing to poor weather conditions, ATC held the flight 3 times, for a total of 1 hour and 17 minutes. It was not until the third holding period that the flight crew finally reported that:

1. the aircraft could not hold longer than 5 minutes
2. it was running out of fuel
3. it could not reach its alternate airport (Boston-Logan International).

Even at that late stage, the flight crew did not communicate effectively to ATC that they were desperately low on fuel and needed immediate clearance to land.

Although the captain had asked the first officer to inform ATC that *we are in an emergency*, the first officer had radioed the controller, saying, *Ah, well, I think we need priority*, later using the words *we're running out of fuel*.

ATC simply replied with 'OK', as it did not interpret the situation as an emergency. None of the controllers involved considered the word *priority*, or the assertions by the flight crew that they were running out of fuel, to indicate an emergency. They stated that they would respond immediately to words such as *Mayday, pan-pan* and *emergency*.

The National Transportation Safety Board (NTSB) determined that the crash occurred because the flight crew failed to properly declare a fuel emergency, resulting in air traffic control tragically underestimating the seriousness of the situation.

image: Avianca Flight 052 | National Transportation Safety Board

Space shuttle disasters

Two tragic space shuttle accidents also identified failures in communication and ineffective communication respectively as contributing factors. In 1986, the space shuttle Challenger broke apart just 73 seconds into flight, killing its 7 crew members. Seventeen years later, in 2003, during re-entry after its 28th mission, the space shuttle Columbia disintegrated, also killing the 7 people onboard. The official investigations on these disasters identified poor communication as a major contributing factor.[9]

The accident investigation reported:

Failures in communication ... resulted in a decision to launch 51-L based on incomplete and sometimes misleading information, a conflict between engineering data and management judgments, and a NASA management system that permitted internal flight safety problems to bypass key shuttle managers.

Rogers Commission Report on the Challenger disaster.[10]

Organizational barriers ... prevented effective communication of critical safety information.

Columbia Accident Investigation Board on the Columbia disaster.[9]

image: Space Shuttle Columbia | NASA

Australian near-disaster, Sydney airport, 29 January 1971

Misheard communications played a major part in a significant incident at Sydney Airport on the night of 29 January 1971, when a fully-loaded Trans Australia Airlines (TAA) Boeing 727, cleared for take-off, scraped the tail of a Canadian Pacific Airlines DC-8 which was backtracking on the runway after landing. Despite damage to the 727's undercarriage and hydraulic system, its crew was able to dump fuel and return safely to Sydney.

At the end of its landing run, the aerodrome controller had instructed the Canadian Pacific crew to '... take taxiway right – call on 121.7' and this instruction was acknowledged. The crew of the Canadian aircraft, however, told an inquiry held later that year they had heard the words '... backtrack if you like – change to 121.7'.[11]

It was the kind of miscommunication which, 6 years later, would lead to the world's worst aviation disaster.

The Tenerife tragedy, 27 March 1977

The world's worst aircraft accident in terms of loss of life was the collision between 2 chartered Boeing 747s (KLM Flight KL 4805 and Pan Am Flight PA 1736) at Tenerife's North (then Los Rodeos) Airport in the Spanish Canary Islands.

Miscommunication was a primary contributing factor to this accident. KLM flight 4805 initiated its take-off run without clearance while the Pan Am aircraft, shrouded in fog, was still on the runway and about to turn off onto the taxiway.

There has been a vast amount of scrutiny and analysis of the Tenerife accident, with the Federal Aviation Administration (FAA) providing an analysis of the communications aspect in its resource material *Lessons learned from Civil Aviation Accidents*.[12]

While there were many contributing factors to this catastrophic event, as there are to any accident, communication was at the forefront. The senior Dutch pilot of the KLM flight failed to understand the messages between the English-speaking pilot of the other aircraft and the Spanish air traffic controller indicating the runway was not yet clear. When you review the cockpit voice recorder (CVR) transcripts, you can find a litany of communication problems and errors.

One of the most crucial communication errors was a misunderstanding of the phrase '*at take-off*'. The following key parts of the CVR transcript display multiple communication errors.

Tenerife transcript

In the final minute before the collision, key misunderstandings occur among all the parties involved. In the end, the KLM pilot initiates take-off even though air traffic control had not issued the proper clearance. The transcript below (courtesy of the FAA and the official Investigation Report) takes up when KLM 4805 is at the end of the runway, in position for departure.[12,13]

1705:41 5 KLM FIRST OFFICER: *Wait a minute, we don't have an ATC clearance. (This statement is apparently a response to an advancing of the throttles in the KLM aircraft by the captain).*

KLM CAPTAIN: *No, I know that. Go ahead, ask.*

1705:44 6 KLM RADIO: *Uh, the KLM 4805 is now ready for take-off and we're waiting for our ATC clearance.*

1705:53 4 TENERIFE TOWER: *(sic) Uh you are cleared to the Papa beacon. Climb to and maintain flight level 90 … right turn after take-off proceed with heading 040 until intercepting the 325 radial from Las Palmas VOR.*

1706:09 6 KLM RADIO: *Ah, roger, sir, we're cleared to the Papa beacon flight level 90, right turn out 040 until intercepting the 325, and we're now (at take-off or uh … taking off).*

When the Spanish, American and Dutch investigating teams heard the tower recording together for the first time, no-one, or hardly anyone, understood that this transmission meant that the KLM aircraft was taking-off.

1706:11 08 *(Brakes of KLM 4805 are released)*

1706:12 25 KLM CAPTAIN: *We gaan … check thrust (We're going … check thrust).*

1706:14 00 *(Sound of engines starting to accelerate)*

1706:18 2–1706:21 2 TENERIFE TOWER: *OK … Stand by for take-off, I will call you. (Only the start of this message could be heard clearly by the KLM crew due to a mutual interference on the radio frequency.)*

Investigators questioned why air traffic control would say 'okay' after KLM had said that it was 'at take-off'. The investigation noted that the controller may have thought that KLM meant 'We're now at take-off position.' This confusion was compounded in the moments immediately following when both air traffic control and Pan Am transmitted simultaneously. This caused a shrill noise in the KLM cockpit that lasted for almost four seconds and made the following communications hard to hear in the KLM cockpit:

image: PH-BUF The Rhine. W.O. Tenerife March 1977 | clipperarctic

1706:19 3 PAN AM CAPTAIN: *No, uh.*

1706:20 3 PAN AM RADIO: *And we are still taxiing down the runway, the Clipper 1736.*

The following messages were audible in the KLM cockpit, causing the KLM flight engineer, even as the KLM plane had begun rolling down the runway, to question the KLM pilot:

1706:25 47 TENERIFE TOWER: *Ah-Papa Alpha 1736 report runway clear.*

1706:25 59 PAN AM RADIO: *Okay, we'll report when we're clear.*

1706:31 69 TENERIFE TOWER: *Thank you.*

1706:32 43 KLM FLIGHT ENGINEER: *Is hij er niet af dan? (Is he not clear, then?)*

1706:34 10 KLM CAPTAIN: *Wat zeg je? (What did you say?)*

1706:34 15 KLM UNKNOWN: *Yup.*

1706:34 70 KLM FLIGHT ENGINEER: *Is hij er niet af, die Pan American? (Is he not clear, that Pan American?)*

1706:35 7 KLM CAPTAIN: *Jawel. (Oh yes. [emphatically])*

The accident report noted, that perhaps influenced by the KLM captain's great prestige making it difficult to imagine an error of this magnitude on the part of an expert pilot, both the co-pilot and the flight engineer made no further objections.

The impact between the two aircraft occurred about 13 seconds later. Based on the Pan Am cockpit voice recording, investigators determined that the Pan Am flight crew saw the KLM coming at them out of the fog about nine and a half seconds before impact.

The Pan Am captain said, *'There he is … look at him! [expletives deleted] is coming!' and his co-pilot yells, 'Get off! Get off! Get off!' The Pan Am pilot accelerates the engines but not in sufficient time to avoid the collision.*

1706:47 44: *The collision occurs.*

Five hundred and eighty-three people died in the accident. Of the 396 people on board the Pan Am aircraft, 61 managed to escape and 335 people died. All 248 people on the KLM aircraft perished. This watershed accident brought human factors, and communication especially, to the forefront of aviation research, and has been considered as the first major aircraft accident where all the contributing factors could be traced back to human factors.[13]

While there were other complications and sources of confusion (including the presence of fog and simultaneous radio calls causing interference), from a linguistic point of view, the 2 instances of miscommunication to note are the phrases 'cleared' and 'at take-off'.

The KLM pilot interpreted the initial clearance (cleared to the Papa beacon) as a clearance to take-off, while it was meant as a clearance for actions after take-off. The KLM pilots then used this to mean 'taking-off' as in 'We are already on the take-off roll/taking-off', in a literal translation of the Dutch syntax. The controller knew English, but not Dutch, and did not recognise the potential ambiguity in this non-standard phrase which he interpreted as the standard 'at take-off point', as in 'we are waiting at the take-off point'.[12]

The KLM pilot not only used non-standard phraseology but should also have waited for the clearance to take off.

Tenerife transcript cont...

Unfortunately, the controller replied 'OK ...', also non-standard phraseology; this was meant as an acknowledgement but could be taken by the pilots as confirming the clearance they thought they had. The KLM captain was in a hurry and took off without clearance, colliding with the other Boeing 747, Pan American PAA1736, still on the runway.[12]

The probable cause as cited in the Dutch investigation report was the KLM aircraft had taken off without take-off clearance, in the absolute conviction that this clearance had been obtained, which was the result of a misunderstanding between the tower and the KLM aircraft. This misunderstanding had arisen from the mutual use of usual terminology which, however, gave rise to misinterpretation. In combination with a number of other coinciding circumstances, the premature take-off of the KLM aircraft resulted in a collision with the Pan Am aircraft, because the latter was still on the runway since it had missed the correct intersection.[12,13]

US aviation journalist and former airline pilot Kathleen Bangs wrote in an article marking the 40th anniversary of the Tenerife disaster:

There's a bit of [the KLM pilot] Van Zanten lurking in every pilot. It manifests in its deadliest form as a blind spot to our own human mistakes, to our own bad luck moments, especially the sneaky ones of our own creation.[14]

The Tenerife disaster has had a lasting influence on aviation safety. An important lesson for aviation communication was an increased emphasis on the importance of using standardised phraseology in radio communication, leading to the implementation of the ICAO language proficiency requirements.

image: Wreckage on the runway of Los Rodeos after the Tenerife airport disaster of March 27, 1977 | Dutch National Archives

Types of communication

When we think of communication, we tend to think first of oral/spoken communication. But in flight operations, as elsewhere, communication takes place via several channels, not just the spoken word. We convey information and create shared meaning through speech, non-verbal and written communication, and visual communication/ visualisations.[1]

Speech

Speaking is the most natural form of communication, yet oral communication is far from perfect. The error rate for oral communication in industrial settings is estimated to be around 3%.[15] In other words, approximately 1 out of every 30 spoken exchanges in workplaces involves a misunderstanding. In aviation, such communication errors can be catastrophic.

Speaking – oral communication – can take place either face-to-face, or remotely via radio or phone. Face-to-face communication involves not only direct speech, but other factors such as non-verbal communication, making it more nuanced. In aviation, radio is an important communication channel, but it can be problematic, because of issues such as accents and non-standard phrases. Also, since you cannot see the other person, important non-verbal communication cues, such as gesture and facial expressions, are not possible.

How would you interpret this exchange?

- **ATC:** Yankee Kilo, you not have my field in sight?
- **Pilot:** Affirmative.

Did the pilot mean 'yes', as in they didn't have the field in sight, or 'yes', they did have the field in sight?[8] The misunderstanding attributed to language difficulties and lack of standard phraseology led to an accident.

A chain of verbal communication via several senders is particularly prone to misinterpretation, which is something the children's game of Chinese Whispers, or the Telephone Game, illustrates.

An often quoted example allegedly happened during World War I when a radio message was sent from the trenches to British Headquarters. The original broadcast was Send reinforcements, we're going to advance. By the time the message arrived via several messengers, it was conveyed as *Send three and four pence, we're going to a dance!*[16]

Non-verbal communication

Non-verbal communication is communication without using words. Much of this type of communication is very subtle and often we may not be aware of it as we communicate information non-verbally by combining several behaviours, such as gesture, facial expression or eye gaze. Some of the types of non-verbal communication are:

1. **Facial expressions:** a large part of non-verbal communication. We usually see the look on someone's face before we hear what they say, and around the world, the facial expressions for happiness, sadness, anger and fear are much the same.

2. **Gesture – deliberate movements and signals:** Formal examples of these are hand signals, such as ground marshalling signals, used extensively in military and aviation environments, to either replace or supplement radio communications. To avoid misinterpretation, hand signals must be unambiguous, clearly and precisely delivered, and universally understood, as per the International Civil Aviation Organization's marshalling signals.[17]

image: Aircraft Marshalling codes | IATA

A common incident resulting from miscommunication with marshalling signals involves aircraft rolling back from a gate because the flight crew has disengaged the park brake before ground staff have put chocks in position. Informally, common gestures can include waving, pointing and using fingers to indicate numbers, as well as cruder gestures to indicate displeasure or dismissal.

3. **Paralinguistics, or vocal communication without words**: in other words, tone, volume, infection and pitch. Responding to a question such as 'how are you?' with an 'I'm fine' response in a flat tone of voice implies not only that you are far from fine, but also not interested in discussing it.
4. **Body language and posture:** can also convey information, but according to recent research, there has been too great a focus on the meaning of defensive postures such as arm- and leg-crossing. Body language, while important in non-verbal communication, is far subtler than commonly assumed, and likely to be combined with other non-verbal communication behaviour, such as facial expression.
5. **Eye gaze:** looking, staring and blinking are important non-verbal behaviours.
6. **Haptics – communicating through touch:** to convey affection, familiarity, sympathy (tend to be used by women), and to assert status or power, (especially by men).
7. **Appearance – what we wear and how we wear it:** We make subtle and snap judgments based on people's appearance, as in the quote 'you will never get a second chance to make a first impression', or as in this pilot's judgment on a potential co-pilot's safety, 'never fly with someone who has gravy on their shirt'.

Visual communication

Visual communication conveys information through signs, graphic design, images, colour and electronic resources. Analogue and glass cockpit flight instruments, remove before flight streamers and placards in the cockpit are examples, as are paper and electronic aviation charts, navigation and runway lights, airport beacons, and take-off and landing distance charts.

Written communication

Written communication includes printed documentation such as flight manuals, but also information in electronic form, such as forecasts, NOTAMs and flight plans. It should be both informative and understood by its intended audience, and in a format which can be readily accessed and applied.

Formal and informal communication

In day-to-day work we tend to communicate both formally and informally. Informal communication is like a relaxed conversation where we might chat and share information about what we did on our days off, or about what is going on at work or with a colleague.

Formal communication on the other hand implies that a record is kept of what has been said or written, so that it can be attributed to its originator. This can include both hardcopy (paper) or soft copy (electronic) mediums such as flight manuals, flight plans, checklists and operational bulletins.

Communication via written material usually means there are few opportunities to clarify or query the message once it is 'sent'.

But even when information is written down, it isn't immune to misinterpretation.

Lost in translation

Subtle nuances and cross-cultural issues have led to some monumental cross-cultural miscommunication blunders concerning brand names and slogans, such as:[18]

- Australian brewer Castlemaine launched its XXXX ('four-ex') beer in the USA using its trademarked jingle, 'I can feel a four-ex coming on', which had proved very successful in the Australian market. Unfortunately for Castlemaine, in the United States, XXXX was the name of a brand of condom.

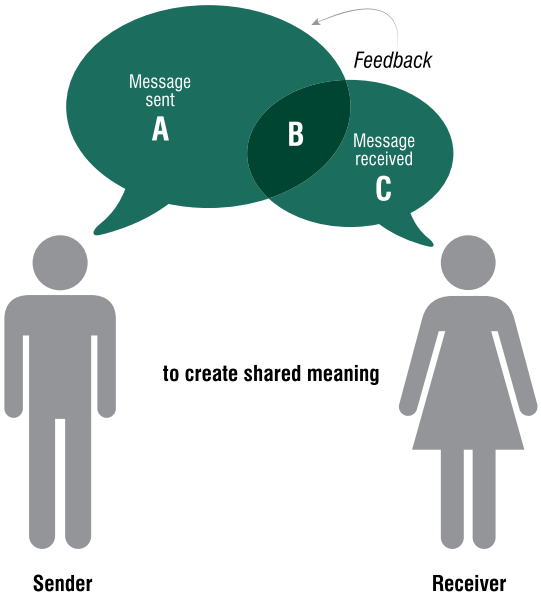
Translation into Chinese has created problems for several companies:

- In 1928, the name Coca-Cola in China was first promoted as *Ko-kou-ko-la*. Unfortunately, 200 Chinese characters are pronounced with sounds that could be used to make the name. The character for 'wax' pronounced 'la' was used in many shopkeepers' signs giving nonsensical meanings such as 'bite the wax tadpole'. Coca-Cola then researched 40,000 Chinese characters and found a close phonetic equivalent, *ko-kou-ko-le*, which can be loosely translated as happiness in the mouth.
- The Kentucky Fried Chicken slogan, *Finger lickin' good*, translates in Chinese as *Eat your fingers off.*
- In Taiwan, the Pepsi slogan *Come alive with the Pepsi Generation* allegedly translated as *Pepsi will bring your ancestors back from the dead*.
- Ford had a similar problem in Brazil when their Pinto model flopped. The company found out that pinto was Brazilian slang for tiny male genitals. Ford removed the nameplates and substituted Corcel, which means horse.

The communication process

The communication process involves a message or communication being sent by the sender through a communication channel to a receiver. The sender must encode the message (the information being conveyed) into a form appropriate to the communication channel, and the receiver then decodes the message to understand its meaning and significance. The following diagram illustrates this process.

Simplified model of communication



So now let's put this theory into everyday words. A practical example of the communication process outlined above could be air traffic control (*the sender*) issuing a clearance (*the message or communication*) via radio transmission (*the communication channel*) to a pilot (*the receiver*). The sender (*air traffic control*) encodes the information into an appropriate form that the receiver *(the pilot*) decodes (*translates into a meaningful form*).

Encoding and decoding

Encoding and decoding is about conveying information in such a way that the receiver understands the message. Effective communication relies on a shared understanding of a common language and vocabulary.

Most professions have their own language; certain words have specific meanings, which to outsiders may sound foreign.

Let's look at a medical example. Most of us know the abbreviation CPR stands for cardiopulmonary resuscitation or DVT stands for deep vein thrombosis but how would you go decoding this statement from a doctor?

So now let's review the results of your blood tests. Your CBC, BMP and LFTs were basically negative. You have prediabetes and a slightly elevated LDL.[19]

Most of us would probably reply with 'Say again?' Again, those in the know would be aware the doctor's abbreviations and language translates to:

So now let's review the results of your blood tests. Your CBC (complete blood count), BMP (basic metabolic panel) and LFTs (liver function tests) were basically negative (normal). You have prediabetes (which doesn't mean you have diabetes – it means your fasting blood sugar level was high which raises future diabetes risk) and a slightly elevated LDL (low-density lipoprotein, better known as 'bad cholesterol').[19]

Aviation has its own specialised language which pilots – native and non-native speakers of English – must learn.

'Aviation English' is the use of standardised, abbreviated, precise and agreed terminology and phraseology. Pilots are expected to gain proficiency in the use of aviation English as their flight training progresses.

To avoid congestion and mutual interference, pilots and ATC must keep their radio communications brief. Because radio communication is one way, messages also must be as clear as possible to eliminate repetition and requests for clarification.

The primary purpose of codes and signals is to keep communications short and concise. If transmissions are short, it saves bandwidth, ensuring the airwaves are available for use.

Aviation English is designed to ensure that meaning is conveyed without needing long explanations.[20] While pilots and air traffic controllers must meet English language proficiency requirements established by the International Civil Aviation Organization (ICAO), it can be quite difficult for those who have learned English as a second language to be proficient in 'aviation English' with its official phraseologies and terminologies.

Q code

The British Government created the 'Q code' in 1909 to make radio communication succinct and unambiguous, and because it could be used and understood by speakers of any language, it was adopted internationally in 1912.

Every message starts with a three-letter group always beginning with 'Q' for 'query'. The three-letter code is used as question and response, followed by information as needed. For example:

- The code 'QRL' corresponds to the question 'Are you busy?' and can be answered with 'QRL' affirming 'I am busy.'
- 'QRB' corresponds to the question 'What is your distance?' with the answer, 'QRB' followed by a number, meaning 'My distance is xxx.'

Remnants of the original Q code are found in aviation today, for example 'QNH' or 'Query Nautical Height', now indicates barometric pressure at sea level (QNH 1013). However, because it was not flexible, and did not allow for the creativity of natural language, the Q code was superseded by radiotelephony speech as the international language for aviation.

In the following aviation example[21] it would probably be a safe bet that the average lay person would find it extremely difficult to decode the meaning, as they don't possess a shared understanding of the context or knowledge of the standardised phraseologies.

Effective communication therefore relies on the sender and receiver speaking the same language, or making allowances and ensuring they ask questions to ensure shared meaning, and that both understand the relevance of the message or information sent.

Party	Message sent	Plain English
PILOT:	Qantas MEL … Qantas 635.	Qantas Melbourne Movement Control, this is Qantas flight QF635.
MOCO (Movement Control):	Qantas 635 … go ahead.	Hello Qantas flight 635, how can we help?
PILOT:	Qantas 635 … we will arrive on blocks at 1500. Have 2 UMs, 2 WCHRs, 1 will need assistance to a taxi. Request a parking bay please.	Hello, advising our estimated arrival time will be 3 pm, we have two unaccompanied minors and 2 people requiring wheelchair assistance on-board. We will need extra ground crew to meet the aircraft and one customer requiring a wheelchair will also need assistance to a taxi. Can we have a parking bay, please?
MOCO:	Copy that Qantas 635. 2 UMs, 2 WCHRs. You are for parking bay 26 … 2 … 6. See you on the ground Qantas MEL.	Understood, we will have 4 gate agents meet the aircraft. Please park at bay 26. See you on the ground.
w:	Kilo QF635 Arrival … Alpha.	Calling gate agent meeting QF635, this is Movement Control.
KILO: (Gate agent)	Go ahead Alpha.	Hello Movement Control, how can we help?
MOCO:	QF635 Requests 2 WCHRs, one to the taxi rank, and 2 UMs.	The QF635 requires extra assistance with 2 customers requiring wheelchairs, 1 that needs to go to the taxi rank, and 2 unaccompanied minors. Please arrange extra gate agents.
KILO:	Copy that Alpha.	No problem, Movement Control.

Why does communication fail in flight operations?

Communication can break down both on the ground and in the air for a number of reasons.

Errors by sender:

- message not sent – sender has a hidden agenda and keeps the information to themselves
- incomplete or ambiguous message sent – sender uses inappropriate method (message left on phone, face-to-face communication not used for important/ sensitive messages)
- inconsistency between oral and non-verbal cues – sender's attitude/body language/ tone does not reinforce an urgent, safety-critical message.

Errors by sender and receiver:

- failure to reach a clear understanding – shared meaning
- wrong mode used e.g. oral message when documentation required, or email sent assuming it would be read.

Errors by receiver:

- message not received
- message misunderstood
- message not clarified.

Many other factors influence effective communication in safety critical industries such as aviation, including:

- attitudes
- conflicts and pressures
- culture
- fatigue
- gender
- high workload
- inadequate language proficiency
- interruptions
- personality
- physical conditions
- stress.[22][23]

ATC/pilot miscommunication arises because of a combination of human and technical communication factors, including:

- blocked transmission
- callsign confusion (the message was wrongly addressed or was taken by another aircraft)
- communication equipment problems caused by malfunction or complete failure of aircraft or ground equipment
- flight crew unintended mismanagement of radio frequency (one of the main causes of prolonged loss of communication)
- frequency congestion
- radio interference making messages difficult or impossible to read.

Errors by sender and receiver can be seen in:

- failure of the read-back/hear-back process
- failure to use standard phraseology
- poor language skills[22].

Workload and distraction can have a major effect on communication and indeed, communication can lead to distraction. The extract below from an accident report demonstrates how ATC communication disrupted a air transport pilot during approach to land.

At 5 nm on final approach to runway 23, the pilot commenced the pre-landing checks, but without extending the landing gear, as he intended to do this further in. However, he was distracted due to radio communications for separation purposes with an incoming BAe-146 aircraft and failed to lower the landing gear. This resulted in the aircraft making a wheels-up landing. The aircraft sustained substantial damage to the lower fuselage, propeller and engine, but the pilot was unharmed.[23]

ATSB Occurrence No: 200105192

Air-ground communication study

The European Organisation for the Safety of Air Navigation, Eurocontrol, conducted a safety study on air-ground communication[21], which found many factors directly affect the quality and frequency of air-ground communications, as shown below.

Factors directly affecting air-ground communication

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

* Sleeping VHF receivers – loss of communication type in which the VHF frequency becomes silent for a period of time

Verbal communication errors

Effective communication involves organisations and individuals minimising potential misunderstanding to overcome any barriers to communication at each stage in the communication process.[24]

As reported by Eurocontrol[21], there are numerous verbal communication errors and contributing factors, including:

- environmental aspects (noise, distractions, stress)
- failure to demonstrate understanding (receiver)
- failure to listen
- failure to plan clear communication of message
- failure to test meaning (receiver) or understanding (transmitter)
- incongruence between verbal and non-verbal communication.
- lack of emphasis of importance and/or urgency
- physiological reasons (speech and/or hearing)
- poor use of pace and tone
- poor use of volume to suit the environment
- technical factors (equipment and transmission medium)
- use of uncommon accent
- use of uncommon language and/or phraseology.

Improving communication

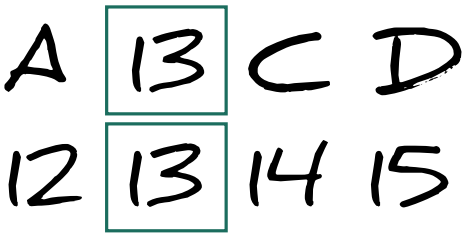
What can you do to improve your verbal communication? Here are some things to keep in mind for effective verbal communication.[21, 23]

- Agree on common language and phraseology. Do not overuse idiomatic language – slang – pick the time and place for such speech.
- Test and agree assumptions. Be aware of possible expectancy errors.

Our expectations set the context for communication and influence the messages we receive. If you expect you are about to be told about a **weather diversion** but are told about a **mechanical issue** instead, you, may unconsciously continue to think about **alternate airports and fuel planning**.

The following example shows how context can influence how we interpret a piece of information.

What do you see in the box in each line below? In fact the symbols are exactly the same but in each case the context leads us to see the symbols as either 'B' or the number '13'.



- Neutralise accents as much as possible.
- Control volume, pitch, tone and pace of speech, particularly with a non-native speaker.
- Stress urgency and importance – ensure you are appropriately assertive. Assertive communication is direct and open, without being either aggressive or excessively polite.

- If possible, choose a good time and place for communication to counter the effects of personal stress and environmental factors i.e. to improve listening opportunity.
- Plan what you want to say.
- Listen actively (receiver and sender); concentrate on what is being said, give your full attention to the speaker, and give feedback by paraphrasing, summarising, questioning and clarifying what is said.
  - » Test meaning (receiver). Repeat/read back or paraphrase the message to make sure you have completely understood it.
  - » Test understanding (sender). Does the receiver understand what you are saying?
  - » Complete feedback: receiver demonstrates understanding and sender observes the effects of the communication on the receiver.
- If your communication is face-to-face, use non-verbal communication to improve/clarify the message, ensuring that your non-verbal communication reinforces/is in harmony with what you are saying. Communicate critical information with the right tone of urgency and dramatic emphasis, for example.
- Maintain communication equipment.

Guidelines and techniques for radio transmission

ICAO's document on aeronautical telecommunications (Annex 10, Volume II) provides rules and procedures for pilot-controller communications. These guidelines and techniques for radio transmission highlight the following objectives:[25]

- carry out transmissions concisely in a normal conversational tone
- make full use of standard phraseologies whenever prescribed in ICAO documents and procedures
- speech-transmitting techniques shall be such that the highest possible intelligibility is incorporated in each transmission.

To reach these objectives, pilots and controllers should:

- enunciate each word clearly and distinctly
- maintain an even rate of speech (not exceeding, typically, 100 words per minute)
- make a slight pause preceding and following numerals; this makes them easier to understand
- maintain speaking volume at a constant level
- be familiar with microphone-operating techniques (particularly in maintaining a constant distance from the microphone if the aircraft does not have a constant-level modulator)
- suspend speech temporarily if it becomes necessary to turn your head away from the microphone.

Best-practice communication protocols

The following communication protocols are good practice for all pilots to help maintain clear communication and avoid confusion or potential errors:[17],[25],[26],[27]

Use correct radio procedures

- Ensure your radio procedures comply with regulatory and company requirements. Write longer messages (e.g. a clearance) down and read back what you have recorded.

Read back clearances

- Read back any clearances containing altitude, heading or speed assignments completely. Always read back any hold-short or position-and-hold instructions.
- For longer clearances (e.g. entry into controlled airspace for an instrument approach) you can reduce errors and improve recall by writing down the information before read back. This can provide an extra check to confirm the information written down is the same as that ATC provided.

When in doubt, verify

- Always seek verification of any clearances you do not understand; or if 2 crew members do not agree on the clearance, verify the information rather than guess.

Use full call signs

- Misunderstandings can occur when full call signs are not used. Acknowledge all communication with a call sign (not a double click of the mike button or stating 'Roger'.

Be alert for similar call signs

- Ensure the controller and other aircraft involved are aware of similar call signs in use.

Use thoughtful radio technique

- Listening for a full 2 seconds before keying a microphone will reduce simultaneous transmissions on the same frequency.

Hearback

- Pilots should never assume that ATC is listening to their read backs or that errors will be corrected.

Keep communication simple

- Clearances, instructions or requests should never contain more than 2 or 3 critical items unless preceded by words such as 'ready to copy?'.

Apply crew resource management to communication

- When a particularly distracting problem arises, or the workload becomes unusually heavy in multi-pilot environments, make one of the pilots responsible for communication while the other remains in control of the flying.
- In single-pilot operations, recognise high workload periods and wherever possible, prioritise and remove unnecessary distractions.

In summary

As Paul Simon said in the early 60's hit The Sound of Silence, it's possible to hear without listening. There's a lot too, in the title of the book It's not what you say, it's the way you say it![28] A calm voice or non-verbal gesture can speak volumes.

Aircraft radio remains an essential communication tool for pilots, but like any other piece of technology, its effectiveness depends on the operator; what is said, how it is said and how we ensure that information is conveyed and interpreted correctly.

A lack of information or misinformation can easily result in pilots not maintaining situational awareness and jeopardising the safety of their flight.

Key points for pilots

Communication is a dynamic process where people engage and interpret messages within a given context or situation. Unfortunately, any form of communication is subject to various factors that can result in errors such as misunderstanding and misinterpretation.

All pilots should be aware of the factors that can affect effective communication and follow protocols to avoid confusion and errors.

Key points for operators

Pilots are often in situations that can very easily lead to communication problems, such as workload, pressure, distractions and fatigue. Bear in mind that communication itself can affect workload. Our cognitive resources are limited, and we cannot dedicate our full attention to communication while simultaneously focusing on another task. If possible, communicate after the task is complete or stabilised. Operators should ensure that their pilots are supported when the workload is high.

Keep in mind that planning what you're going to say and keeping it succinct, is better than talking spontaneously: the more information you convey, the greater the chance of error. Communication is an integral part of areas such as decision making, situational awareness, teamwork and stress management, so having pilots with well-developed communication skills is critical for safe and effective performance. To build and maintain this communication competency, air transport operators should debrief and provide regular feedback to their pilots, reinforcing specific examples of effective and poor communication in a non- judgmental way.

Resources

Key terms

aircraft marshalling Refers to the universal visual communication signals (usually via body language) between ground personnel and pilots in order to lead an aircraft, for example, to the correct parking position at an airport or aerodrome.

aviation communication The means by which aircraft crews connect with other aircraft and people on the ground to relay information. Aviation communication is a crucial component of safe operations on the ground and in the air.

aviation English The international language of civil aviation.

communication The act of conveying intended meanings from one entity or group to another through the use of mutually understood words, gestures or symbols.

decoding How a recipient of information is able to understand and interpret the message.

encoding Translating information into a message in the form of symbols that represent information, ideas or concepts.

formal communication Communication in which a record is kept of what has been said or written, so that it can be attributed to its originator. On the whole, written communications are formal where there is a system or rule for the information.

hearback Failure to notice and correct a readback error (e.g. ATC listening and checking to ensure a pilot gives the correct readback).

ICAO English language requirements for pilots, flight crew and air traffic controllers A condition of a licence that a professional pilot or air traffic controller should have demonstrated their skills in plain English and English medium phraseology to a standard equivalent to level 4 (Operational) in the ICAO universal rating scales.

informal communication Casual conversations where information is exchanged spontaneously with no set rules, processes, system or formalities.

information transfer The process of transferring information from one person or location to another.

miscommunication To communicate mistakenly, unclearly or inadequately.

non-verbal communication The process of sending and receiving messages (sharing meaning) without using words, either spoken or written, but rather using facial expressions, eye contact, gestures and signals.

phraseologies A set of communication rules for simplified language communication, carefully developed to provide maximum clarity and brevity in communications while ensuring that phrases are unambiguous. The aeronautical phraseology is based on standards developed by the International Civil Aviation Organization.

readback A procedure whereby the receiving person/entity repeats a received message or an appropriate part thereof back to the transmitting person/entity so as to obtain confirmation of correct reception (e.g. ATC route clearances).

situational awareness The perception of the elements in the environment within a volume of time and space, the comprehension of their meaning, and the projection of their status in the near future, or What has happened? What is happening? What might happen?

translation The process of translating words or text from one language into another.

verbal communication The process of sending and receiving messages (sharing information) using words.

References

1 *English Oxford Living Dictionaries*. Definition of communication. See: en.oxforddictionaries.com/definition/communication

2 Estival, D., Farris, C. and Molesworth, B. (2016). *Aviation English. A lingua franca for pilots and air traffc controllers*, pp. 3–4. Routledge, London, England.

3 Civil Aviation Authority (UK) (2020). CAP 719 Fundamental Human Factors Concepts. See: caa.co.uk/publications

4 Australian Transport Safety Bureau (ATSB) (2017): Fuel exhaustion and forced landing involving Beech 58, VH-PBU, 6 km n of Normanton Airport, Queensland, 26 June 2017. Investigation number: AO-2017-067. See: atsb.gov.au

5 ABC News (USA) (2006). Tragic 'Misunderstanding' in West Virginia Mine Accident. See: abcnews.go.com/US/ story?id=1469171

6 Laroque, M. (2014). Top 10 Times Miscommunication Had Awful Consequences. TopTenz. See: toptenz.net/top-10-times-miscommunication-had-awful-consequences.php

7 Billings, C. E. and Cheaney, E. S. (1981). Information Transfer Problems in the Aviation System. NASA Technical Paper 1875. NASA Ames Research Center, Moffet Field, California, USA.

8 National Transportation Safety Board (1990). Aircraft Accident Report: Avianca, the Airline of Columbia Boeing 707-321B, HK 2016, Fuel Exhausation, Cove Neck, New York, January 25th, 1990. See: ntsb.gov/investigations/Pages/Investigations.aspx

9 Howell, E. (2017). Columbia Disaster: What Happened, What NASA Learned. Space.com. See: space.com/19436-columbia-disaster.html

10 Report of the Presidential Commission on the Space Shuttle Challenger Accident (1986). See: ntrs.nasa.gov/citations/19860015255

11 'A bump in the night' (2018). *Flight Safety Australia*. See: flightsafetyaustralia.com/2018/02/a-bump-in-the-night

12 Federal Aviation Administration (FAA) (2015). Lessons Learned From Civil Aviation Accidents.

13 Aviation Safety Network (ASN) (1977). Pan Am and KLM Collision at Tenerife. See: aviation-safety.net/database/record.php?id=19770327-0

14 Bangs, K. (2017). Calamity and Coincidence: 40 Years Later Are We at Risk of Another Tenerife? See: disciplesofflight.com/remembering-tenerife-airport-disaster/

15 Kirwan, B. (1994). *A Guide to Practical Human Reliability Assessment*. Taylor & Francis, London, England.

16 Quote Investigator (2011). Military Command: Send Three and Fourpence. We're Going to a Dance. See: quoteinvestigator.com/2011/08/26/reinforcements/

17 International Civil Aviation Organization (ICAO) (2005). Rules of the Air. Annex 2 to the Convention on International Civil Aviation. Tenth Edition.

18 Hughes, Tony. J. (2015). Lost In Translation. Funny True Miscommunication. See: linkedin.com

19 Lin, K. (2011). Decoding Doctor-Speak: Translations of Common Medical Terms. See: health.usnews.com/health-news/blogs/healthcare-headaches/2011/07/25/decoding-doctor-speak-translations-of-common-medical-terms

20 Skybrary (2017). Verbal Communication. See: skybrary.aero/articles/verbal-communication

21 Escape (2016). How To Speak Like A Qantas Pilot: Aviation Terms Explained. See: escape.com.au/travel-advice/how-to-speak-like-a-qantas-pilot-aviation-terms-explained/news-story/0641df0abb6b715ee11d96ee3ea3461a

22 McMillan. D. '...Say again?...' Miscommunications in Air Traffc Control (1998). pacdeff.com

23 Australian Transport Safety Bureau (ATSB) (2004). Dangerous Distraction: An examination of accidents and incidents involving pilot distraction in Australia between 1997 and 2004. Aviation Research Investigation Report B2004/0324, p. 18. See: atsb.gov.au

24 Skills You Need (2018). What is Communication? See: skillsyouneed.com/ips/what-is-communication.html

25 International Civil Aviation Organization (ICAO) (2001). Aeronautical Telecommunications. Annex 10 to the Convention on International Civil Aviation. Volume II Communication Procedures including those with PANS status. See: applications.icao.int/postalhistory/annex_10_aeronautical_telecommunications.htm

26 International Civil Aviation Organization (ICAO) (1998). Human Factors Training Manual. Doc 9683-AN/950, 1st edition.

27 Aviation Knowledge(2010.) How to improve Communication between ATCOs and Pilots. See: aviationknowledge.wikidot.com/aviation:better-communication-between-atco-and-pilots

28 Parker, Michael (2014). *It's Not What You Say It's The Way You Say It: How to speak and present with power and persuasion*. Vermilion, England.

casa.gov.au