
Systematic Literature Review: The Role Of ICAO Standard Phraseology In The Prevention Of Aircraft Accidents And Incidents

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Abstract

Aviation safety is significantly influenced by the effectiveness of communication between pilots and Air Traffic Controllers (ATC). One effort to minimize communication errors is the implementation of ICAO Standard Phraseology as an international communication standard in aviation operations. This study aims to analyze the role of ICAO Standard Phraseology in preventing aircraft accidents and incidents through a Systematic Literature Review (SLR) approach. The review process was conducted using the PRISMA method, including the identification, screening, evaluation, and synthesis of literature obtained from various academic databases. The results of the review of nine articles indicate that ICAO Standard Phraseology contributes to reducing communication ambiguity, suppressing human error, increasing situational awareness, and supporting more informed decision-making between pilots and ATC. However, the effectiveness of its implementation is still influenced by Aviation English skills, personnel experience, and adherence to communication procedures. Therefore, aviation communication training and evaluation need to be continuously improved to optimally support aviation safety.

Keywords: ICAO Standard Phraseology, Aviation Communication, Aviation Safety, Air Traffic Controller, Human Error.

INTRODUCTION

The aviation industry is a transportation sector that demands the highest level of safety due to the complex, dynamic, and high-risk nature of its operations. In such an operational environment, communication is a crucial element in ensuring that all flight activities are conducted safely, orderly, and efficiently. Communication between pilots and Air Traffic Controllers (ATCs) serves not only as a means of exchanging information but also as a foundation for safety-related decision-making. Consequently, clarity, precision, and uniformity in message transmission are aspects that cannot be overlooked in modern aviation navigation systems (Sawera Qureshi et al., 2026).

As global air traffic volume increases, so does the complexity of operational communication. Pilots and air traffic controllers (ATCs) from diverse nations—bringing varying linguistic backgrounds, cultural contexts, and levels of proficiency—must interact within a work environment that demands rapid and accurate responses. Under these conditions, the potential for communication errors poses a challenge that can impact aviation safety. Numerous investigation reports into aviation accidents and incidents indicate that miscommunication remains a contributing factor to adverse events. Errors in understanding instructions, the use of non-standard terminology, ambiguous information delivery, or failures to confirm communications can trigger operational errors, potentially leading to incidents or even accidents. Major accidents in aviation history illustrate the critical importance of effective communication in flight operations. The 1977 Tenerife disaster—still recorded as the deadliest aviation accident in history—serves as a prime example of how unclear communication and differing interpretations of radio messages can contribute to a catastrophe. Similar patterns appear in various other accidents and incidents, demonstrating that communication plays a pivotal role in the chain of events leading to an occurrence. These findings highlight that efforts to enhance aviation safety depend not only on technological advancements but also on the effectiveness of communication among the personnel involved in flight operations (Ra'no Turaevna ERGASHOVA et al., 2023).

In response to the need for uniform and internationally comprehensible communication, the International Civil Aviation Organization (ICAO) established Standard Phraseology as the communication standard for pilots and air traffic controllers (ATC). This standard phraseology is designed to reduce ambiguity, enhance consistency in information delivery, and ensure that every instruction carries the same operational meaning for all airspace users. The use of standardized phraseology enables more efficient communication and serves as a layer of defense within the aviation safety system. By implementing standard phraseology, potential errors arising from differing interpretations can be minimized, thereby reducing the risk of incidents and accidents (Hilary S. Z. Wynne, 2025).

Nevertheless, the effective implementation of ICAO Standard Phraseology faces various challenges. Variations in English proficiency, cultural influences, personnel experience levels, and the tendency to use non-standard language in certain situations can impact the quality of operational communication. Furthermore, during emergencies or abnormal conditions, the need to convey detailed information often prompts the use of "plain language," which carries a potential risk of misunderstanding if not employed correctly. These conditions demonstrate that the mere existence of communication standards is insufficient without the competence and compliance of users in applying them. Numerous studies have explored the relationships between aviation communication, human factors, and operational safety. However, research specifically integrating findings on the contribution of ICAO Standard Phraseology to the prevention of aircraft accidents and incidents remains relatively limited. Consequently, there is a need for a study that systematically compiles and analyzes existing research to provide a comprehensive understanding of the role standard phraseology plays in supporting aviation safety. Against this backdrop, this study employs a Systematic Literature Review approach to identify, analyze, and synthesize research findings regarding the role of ICAO Standard Phraseology in preventing aviation accidents and incidents, as well as the factors influencing its effectiveness in pilot-ATC communication (Dumdumaya, 2025).

RESEARCH METHODS

This study employs the Systematic Literature Review (SLR) method to identify, evaluate, and synthesize research findings regarding the role of ICAO Standard Phraseology in the prevention of aircraft accidents and incidents. The SLR method was selected because it enables researchers to gain a comprehensive and systematic understanding of prior research developments while minimizing potential bias during the literature collection and analysis processes.

The study was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework, encompassing the stages of identification, screening, eligibility assessment, and article inclusion. The identification phase involved searching various reputable electronic literature databases, such as Scopus, ScienceDirect, Wiley Online Library, SpringerLink, Taylor & Francis Online, and Google Scholar. Literature searches were performed using a combination of relevant keywords: "ICAO Standard Phraseology," "Aviation Communication," "Aircraft Accident," "Aircraft Incident," "Air Traffic Control Communication," "Pilot-ATC Communication," "Aviation Safety," and "Human Factors in Aviation." These keywords were combined using Boolean operators (AND and OR) to yield more specific search results (Franciele Rodrigues Guarienti & Fabrício Peixoto Ribeiro, 2026).

The retrieved literature was screened based on established inclusion and exclusion criteria. Inclusion criteria comprised: (1) scientific articles published in reputable national or international journals; (2) articles addressing aviation communication, ICAO Standard Phraseology, aviation safety, or human factors in flight operations; (3) articles available in full-text format; and (4) articles published between 2000 and 2025. Conversely, exclusion criteria included: (1) articles unrelated to communication between pilots and Air Traffic Controllers (ATCs); (2) articles that had not undergone

peer review; (3) publications such as opinion pieces, editorials, or news reports; and (4) duplicate articles found across multiple databases. (Gabrielė MASIULIONIENĖ & Gytė TUPČIAUSKAITĖ, 2023)

Subsequently, articles meeting the criteria underwent a quality assessment process, evaluating the alignment of research objectives, the methods employed, and the relevance of findings to the study topic. Articles that passed this assessment were then analyzed using thematic analysis. This analysis involved categorizing research findings into several key themes, such as the role of standard phraseology in reducing communication ambiguity, enhancing situational awareness, mitigating human error, preventing runway incursions, and addressing challenges in implementing standard phraseology within the international aviation environment. (Aline, 2023)

The synthesized results from the literature were then used to address the research focus regarding the contribution of ICAO Standard Phraseology to the prevention of aircraft accidents and incidents. Through this approach, the study aims to provide a comprehensive overview of the effectiveness of standard phraseology in supporting aviation safety systems and to identify factors influencing the success of its implementation in operational aviation communication. (Hazrati, 2024).

RESULTS AND DISCUSSION

A literature search across several academic databases yielded a number of articles concerning aviation communication, Aviation English, ICAO Standard Phraseology, and aviation safety. Following identification, screening, and suitability assessment based on inclusion and exclusion criteria, nine articles were selected as relevant for further analysis. These articles, published between 2022 and 2025, originate from various countries and cover diverse research focuses—ranging from the use of standard phraseology, aviation language proficiency, and communication factors in aviation accidents to the development of learning media for radiotelephony and Aviation English (Delmio A.M.G de Sousa et al., 2025).

All selected articles were subsequently analyzed based on their research objectives, methodologies, and key findings regarding the role of ICAO Standard Phraseology in supporting aviation safety. A summary of the data extracted from each article is presented in Table 1 (Gharibnavaz, 2022).

Tabel 1. Article Review

No	Name & Years	Title	Method	Discussion
1	Begimbayeva, M.G., Kulgildinova, T.A., & Mussabekova, G.Z. (2023)	Characteristics of the formation of aviation discourse in future foreign language teachers	The research employs a descriptive-evaluative method aimed at describing individual and group behavior during the decision-making process, particularly when formulating emergency situation scenarios. This method is explanatory rather than prescriptive. The research also constitutes an experimental study involving the development of a "Language and Communication in Aviation" module that covers topics related to emergency situations.	The discussion emphasizes developing aviation discourse skills for prospective teachers and professionals, aligned with ICAO language proficiency standards to enhance aviation safety. It defines discursive competence as integrating thesaurus-gnostic and strategic-operational sub-competencies essential for professional communication. The study explores directive speech acts and case studies on emergencies like Rejected Take-Offs, bird strikes, and fires, alongside human factors. Course materials employ project-based learning and simulations using Emergency and Abnormal Checklists to help students master aviation vocabulary and adapt to English-speaking environments, ultimately improving safety and intercultural communication.
2	Gharibnavaz, S. & Lutfiyah 2022	The Most Common Errors in Aviation English Communication	This study employs a qualitative method. Data were collected over a ten-year period through observation and documentation, focusing on communications between pilots and Air Traffic Controllers (ATC) in several countries,	This discussion identifies and analyzes common radiotelephone communication errors between pilots and ATC in Indonesia, including non-standard ICAO phonetic alphabet pronunciation, incorrect callsign transmission, improper number pronunciation, inconsistent time and altitude

			particularly Indonesia. The collected data were then analyzed and compared against standard documents, such as those from the ICAO (International Civil Aviation Organization) and CASR (Civil Aviation Safety Regulations).	reporting, and frequency transmission mistakes. Primary causes include lack of practice, infrequent manual review, rushing, and imitating incorrect habits. These errors pose significant risks to aviation safety by creating potentially unsafe situations.
3	Pranoto, D.C.Y. & Susanto, F. (2024)	Challenges in Learning ICAO Radiotelephony: Students' Perspective	This study employs a qualitative method with a case study design. Data were collected through semi-structured interviews with ATC students from Cohort 13, direct classroom observations, and document analysis, including the ICAO Doc 9432 Manual. Data analysis was conducted using a thematic analysis approach to identify themes and sub-themes emerging from the students' experiences and perspectives.	This discussion identifies key challenges ATC students face in mastering ICAO radiotelephony: linguistic barriers with specialized phraseology differing from general English, difficulty grasping context-specific aviation terminology including proper pausing and intonation, gaps between theoretical knowledge and practical application, and challenges handling unexpected emergency situations requiring rapid adaptation. Students address these through collaborative learning with peers and repetitive independent practice. The study recommends enhanced language support, interactive methods like simulations and role-play, and collaborative learning environments to improve training effectiveness.
4	Bieswanger, M., Mathews, E., & Valdes, E. (2025)	Supporting the Investigation of Language and Other Communication Factors	This research is a qualitative study employing a case study approach and document analysis. The methods used include: 1) a literature review on language factors in aviation safety; 2) an analysis of existing accident investigation reports, specifically the B737	This discussion highlights the lack of systematic attention to language factors in aviation accident investigations. Although frequently mentioned, language issues rarely appear in formal findings unlike other human factors such as fatigue or stress. Investigators face obstacles including limited industry awareness, language

			accident in Greece (2005); and 3) the development and application of a taxonomy and checklist to identify and classify language factors. The research was conducted by a committee comprising pilots, air traffic controllers, safety investigators, and linguists.	complexity, unclear guidance, and difficulty distinguishing language-related issues. A 2005 B737 accident case study demonstrates how accent, pronunciation, vocabulary, and comprehension problems contributed to CRM failures. Researchers recommend using a communication factor taxonomy and language information checklist to systematically identify, classify, and report language factors for improved safety recommendations.
5	de Sousa, D.A.M.G., Rochmawati, L., Fatmawati, & Sukma, M.M. (2024)	Development of an Air Traffic Control Phraseology Handbook to Improve Aviation Communication Effectiveness for Aviation Cadets at Surabaya Aviation Polytechnic	This study employs a Research and Development (R&D) approach using the 4D model (Define, Design, Develop, Disseminate). However, due to time and resource constraints, the research was conducted only up to the Develop stage. Data were collected through observation, interviews, expert validation (content, language, and design experts), and limited trials with cadets. Data analysis was performed using descriptive qualitative methods and simple quantitative analysis (validation score percentages).	This study developed an ATC phraseology guidebook to address Surabaya Aviation Polytechnic cadets' difficulties applying ICAO standard phraseology. The Define stage identified lacking contextual, accessible learning materials aligned with cadets' competency levels. The Design stage produced a draft based on ICAO Doc 4444 Chapter 12, using a three-column format (situation, phraseology, Indonesian meaning). Expert validation awarded 100% suitability across language, content, and design aspects. Limited trials showed improved cadet understanding of phraseology usage. The guidebook shows potential as an effective learning tool for enhancing aviation communication, though extensive field testing remains needed, and is recommended for use across aviation educational institutions.
6	Hazrati, A. (2024)	Unstable Approach: Exploring Legal Aspects,	This study employs a data-driven qualitative approach. Data were gathered from various sources, including	This discussion addresses unstable approaches, accounting for 65% of aviation accidents, with 95–97% not resulting in

		Linguistic and Sociocognitive Dimensions	ICAO, FAA, and CANSO documents, reports on accidents and incidents involving unstable approaches, and academic research. A discourse analysis method was used to examine the interactions between air traffic controllers (ATC) and pilots within accident reports. The study is descriptive-analytical in nature, aiming to propose operational solutions based on an analysis of secondary data from various aviation accidents and incidents.	go-arounds despite SOP requirements. Primary causes include sociocognitive factors (cognitive biases, "press-on-itis," cultural power distance, co-pilot reluctance to challenge captains), linguistic factors (lacking standard phrases for communicating approach instability), and legal factors (ATC duty of care). Proposed solutions include: a new standard phrase "Confirm Stabilized Approach" for ATC inquiries, ATC-suggested go-arounds in risky situations, and ATC-instructed go-arounds in extreme scenarios while maintaining pilot authority. The study concludes that integrating intuition, critical thinking, SOPs, and standardized communication is essential for mitigating unstable approach risks.
7	Masiulionienė, G. & Tupčiauskaitė, G. (2023)	Bridging the Gap Between ICAO Level 4 and 5 in Aviation English: Expectations and Outcomes	This study employs quantitative and qualitative methods using a descriptive analysis approach. Data were collected from 161 students in the Aircraft Pilot and Air Traffic Control study programs at Vilnius Tech (AGAI) from the 2013–2018 cohorts. Data sources included: 1) Entrance English language state exam results; 2) Aviation English module grades (AE1, AE2, AE7); and 3) ICAO proficiency exam simulation speaking tasks, assessed by certified examiners using the ICAO rating scale (covering six criteria: pronunciation, structure, vocabulary,	This discussion analyzes students' Aviation English proficiency gaps between ICAO Level 4 and Level 5. While 96% possess General English backgrounds (CEFR B2–C2) sufficient for Level 4, only 20% achieved Level 5 overall despite 45% demonstrating high General English proficiency. Most challenging areas for reaching Level 5 were structure (53.8% stuck at Level 4, 12.5% failed), vocabulary (59.6% at Level 4 due to limited range and paraphrasing skills), and fluency (44.2% at Level 4 from inconsistent discourse markers and connectors). The study recommends revising training programs to emphasize grammatical structures,

			fluency, comprehension, and interaction). Analysis was conducted to determine the students' overall proficiency levels and identify the language areas posing the greatest difficulty in achieving ICAO Level 5.	vocabulary expansion, and speaking fluency to improve graduates' employment prospects and aviation safety contributions.
8	Pacheco, A. (2023)	Communication in the Oil and Gas Industry: contributions from Applied Linguistics and Aviation English	This study employs a qualitative approach with a multidisciplinary study design comprising three stages. Stage 1: Analysis of 16 OGI accident reports using corpus linguistics (WordSmith software) to identify communication factors and develop a preliminary taxonomy based on the Aviation Communication and Language Factors Taxonomy (Mathews, 2013). Stage 2: Online interviews with five workers from three different offshore operations to gather metalinguistic data regarding communication training and practices. Stage 3: On-site language data collection (transcription of conversations during cargo handling operations), analyzed using Conversation Analysis (Neville, 2006) and Grice’s Cooperative Principle (1975).	This discussion examines communication dynamics in the oil and gas industry (OGI) and potential contributions from applied linguistics and Aviation English to enhance safety. Key findings reveal procedural factors as the core communication taxonomy issue, with accident reports citing lack of written protocols, poor communication management, and absent standardized language. Despite no specific language training, standardized operational behaviors from rigorous technical training underpin communication practices, though extreme work experience levels pose risks and politeness serves as a common strategy. Linguistic data shows limited vocabulary with high morphological variation, first-person plural constructions for politeness, and need for standardized information confirmation. The study recommends developing minimum standard phraseologies for basic functions, fostering metalinguistic awareness in training, and optimizing communication through assertive structures and standardized confirmation practices.

9	Ergashova, R.T. (2023)	Evolution of Aviation Terminology: Historical Analysis	This study employs a qualitative approach utilizing historical and descriptive analysis methods. The methods employed include: 1) A literature review of aviation-related texts and historical documents. 2) Document analysis from various sources, such as ICAO and IATA publications and academic literature on aviation terminology. 3) A historical-linguistic approach to trace the origins, development, and evolution of aviation terms over time. The study is descriptive-analytical in nature, focusing on the factors influencing the evolution of this terminology.	This study traces aviation terminology's evolution from 1903 to today, showing how terms shifted with each era: early flight (pitch, roll, yaw, aileron, rudder), World War I (fighter, bomber, dogfight), interwar years (wing loading, cruising speed), World War II (radar, jet engine, supersonic), and the post-war to modern period (GPS, autopilot, UAV, drone, electronic ticketing). It highlights English's role as aviation's global language, driven by history, ICAO standardization, safety, and worldwide operations. Key influences include technology, ICAO/IATA standards, human factors, culture, acronyms, and communication tools. Understanding this history clarifies aviation's growth and the need for clear, standardized communication in this specialized field.
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An analysis of nine articles meeting the inclusion criteria revealed that ICAO Standard Phraseology plays a significant role in supporting aviation safety by enhancing the quality of communication between pilots and Air Traffic Controllers (ATCs). The literature synthesis identified five key themes: (1) reduction of communication ambiguity, (2) prevention of human error, (3) improvement of aviation language proficiency, (4) support for situational awareness and decision-making, and (5) challenges in implementing standard phraseology. (Dani Chandra Yudho Pranoto & Fajar Susanto, 2024)

The Role of ICAO Standard Phraseology in Reducing Communication Ambiguity

Most studies confirm that the use of ICAO standard phraseology serves to ensure uniformity of meaning in radiotelephony communication. Research by Gharibnavaz and Lutfiyah (2022) indicates that the use of terms, numbers, callsigns, and pronunciations that deviate from ICAO standards can lead to misunderstandings between pilots and ATCs. Such errors can result in instructions not being accurately understood, thereby increasing the risk of operational incidents. (Markus Bieswanger et al., 2026).

These findings are reinforced by research conducted by Pacheco (2023), which states that the existence of a standard language and structured communication procedures is a crucial factor in preventing communication errors in high-risk work environments. With standard phraseology in place, every instruction carries a consistent meaning, thereby reducing the likelihood of differing interpretations between the sender and the receiver of the message.

These results indicate that ICAO Standard Phraseology serves as a communication risk mitigation mechanism by eliminating ambiguity and enhancing information clarity within the aviation operational environment.

The Contribution of Standard Phraseology to Reducing Human Error

Human error is a primary factor contributing to aviation accidents and incidents. Study results demonstrate that the use of standard phraseology can reduce the likelihood of errors stemming from human factors.

Research by Bieswanger, Mathews, and Valdes (2025) found that various aviation accidents often involve language-related factors that are not systematically identified during investigations. Factors such as accents, pronunciation, listening comprehension, and limited vocabulary can lead to ineffective communication and contribute to failures in flight crew coordination.

Furthermore, Hazrati (2024) demonstrated that a lack of clear phraseology during unstable approach situations can delay the decision to execute a go-around. Therefore, the development of additional phraseology specific to certain situations is considered capable of enhancing communication effectiveness and reducing the potential for human error under critical operational conditions (M.G. Begimbayeva et al., 2023).

These findings indicate that ICAO Standard Phraseology serves as a safety barrier within the aviation safety system, helping to minimize human error.

The Importance of Language Competence and Phraseology Training

The effectiveness of using ICAO Standard Phraseology depends not only on the existence of communication standards but also on the users' ability to apply them consistently.

Research by Masiulionienė and Tupčiauskaitė (2023) shows that while most learners are able to reach ICAO Level 4, only a small fraction successfully achieve Level 5. The greatest difficulties lie in the areas of language structure, vocabulary, and speaking fluency. This demonstrates that adequate language proficiency is a crucial factor in the successful application of standard phraseology (Sawera Qureshi et al., 2026).

Similar findings were reported by Pranoto and Susanto (2024), who identified linguistic barriers and the gap between theory and practice as major challenges in ICAO radiotelephony training. Meanwhile, research by de Sousa et al. (2024) indicates that the use of ICAO-based phraseology manuals can enhance the understanding and communication skills of aviation cadets.

Thus, continuous training, the use of relevant learning materials, and operational communication simulations are vital factors in improving the effectiveness of standard phraseology implementation (Ra'no Turaevna ERGASHOVA et al., 2023).

Support for Situational Awareness and Decision-Making

Effective communication contributes directly to enhancing situational awareness for both pilots and air traffic controllers (ATCs). Information conveyed clearly, concisely, and in accordance with standards enables all parties to accurately understand operational conditions and make appropriate decisions. Research by Begimbayeva et al. (2023) emphasizes the importance of discursive competence when dealing with various operational situations and emergencies. The use of case-based simulations helps participants understand how phraseology is employed to maintain situational awareness and team coordination (Hilary S. Z. Wynne, 2025).

Furthermore, Hazrati (2024) explains that effective standardized communication enables pilots and air traffic controllers (ATC) to detect unsafe approach conditions early, allowing for immediate corrective action. Thus, standard phraseology plays a vital role in facilitating rapid and accurate decision-making during flight operations.

Challenges in Implementing ICAO Standard Phraseology

Despite its significant benefits, the implementation of ICAO Standard Phraseology faces various challenges. Research indicates that differences in language background, culture, experience, and user competence levels can impact the quality of aviation communication.

A study by Gharibnavaz and Lutfiyah (2022) found that the use of local pronunciations and non-standard communication practices remains common in flight operations. Additionally, Bieswanger et al. (2025) revealed that linguistic factors often receive insufficient attention in aviation safety investigations. Other findings suggest that, during emergencies, the use of plain language is often unavoidable, as standard phraseology cannot always accommodate every situation encountered. Therefore, balancing the use of ICAO Standard Phraseology with the ability to communicate using plain language is a crucial aspect to consider in aviation training (Franciele Rodrigues Guarienti & Fabrício Peixoto Ribeiro, 2026).

Synthesis of Findings

Overall, the study results indicate that ICAO Standard Phraseology contributes significantly to the prevention of aircraft accidents and incidents. Standard phraseology helps reduce communication ambiguity, enhance situational awareness, support accurate decision-making, and minimize human error. However, the effectiveness of its application is heavily influenced by language competence, training quality, adherence to procedures, and personnel adaptability in complex operational situations. Consequently, improving the quality of Aviation English education and simulation-based radiotelephony training, alongside strengthening a culture of communication safety, must continue to be prioritized to support the optimal implementation of ICAO Standard Phraseology within modern aviation systems.

CONCLUSIONS

Based on a systematic literature review of nine relevant articles, it can be concluded that ICAO Standard Phraseology plays a crucial role in preventing aircraft accidents and incidents by enhancing the quality of communication between pilots and Air Traffic Controllers (ATCs). The use of standard phraseology has been proven to reduce communication ambiguity, improve the consistency of information delivery, and minimize the risk of misinterpretation that could compromise flight safety.

The study results indicate that communication utilizing standard phraseology contributes to reducing human error, enhancing situational awareness, and supporting faster and more accurate decision-making across various operational conditions, including abnormal and emergency situations. Furthermore, the application of ICAO Standard Phraseology serves as a vital layer of defense within the aviation safety system by fostering a shared understanding among all airspace users.

However, the effectiveness of implementing standard phraseology remains influenced by various factors, such as Aviation English proficiency, personnel experience levels, cultural and linguistic differences, and adherence to established communication procedures. Some studies also indicate that the use of non-standard phraseology persists, potentially leading to miscommunication and increased operational risk.

Therefore, continuous efforts are required to enhance aviation communication competence through Aviation English training, scenario-based radiotelephony simulations, a deeper understanding of ICAO Standard Phraseology, and periodic evaluations of pilot and ATC communication skills. With consistent implementation and adequate competence, ICAO Standard Phraseology can function optimally to support a safer, more effective, and more efficient aviation system.

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