



Checklist and Alert Language: Impact on ESL Pilot Performance in Airline Operations

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Abstract. Flight crewmembers utilize checklists during typical phases of flight, which may also encompass non-normal conditions. Written English language on checklists combined with crew alerting can be used by flight crewmembers to read and comprehend system related issues, and respond to system conditions on the flight deck. Design and integration of English language on checklists and alerting systems should provide information that can be utilized for flight decision-making purposes. English language can be challenging for English as-a-second language flight crewmembers. Review of literature suggests that ESL adults experience fundamental challenges with reading and interpreting written English language text corpora based on their background knowledge, English language proficiency, and contextual use of written English language in airline operations. This paper provides a survey of ESL flight crew performance issues when they use checklists and alerting systems during non-normal conditions. Survey results indicated that flight crewmember use of written English language checklists has an impact on their performance in airline operations. Design and integration of written English language on checklists and alerting systems were factors leading to ESL flight crewmember procedural divergence and misunderstandings. Flight crewmembers' metacognitive strategy use, background knowledge, and their English language proficiency (reading comprehension level), were factors that impacted their performance and flight safety. Future studies should focus on ESL flight crewmember use of written English language on checklists and alerting systems and impact on flight crewmember performance in airline operations.

Keywords: Lexis · Human performance · System safety · Flight deck · Crew station design · Cognition

1 Introduction

English language can be considered challenging to read and interpret by adults in various sociotechnical environments. English as-a-second language (ESL) adult reading comprehension has the potential to be impacted by design and integration of written English language vocabulary words on alert and information systems. Adult English

Note: Literature Review, Methods, and Discussion sections are from Sevillian (2017).

language proficiency can also be a factor that influences their performance, which may impact ESL adult ability to read and understand word meaning. In the maritime industry, ESL seafarer's misunderstandings while they read and comprehended English language led to accidents (MAIB 2005). These accidents were related to seafarer's ability to read and understand vocabulary words on operational safety documentation. Aviation industry has indicated use of technical information by ESL crewmembers is also challenging, especially when using documentation in an operational environment. Drury and Ma (2003) found that maintenance personnel experience difficulties reading and comprehending safety information related to tasks. On the flight deck, use of written English language by ESL flight crewmembers has been noted as a factor influencing their performance. According to IAC (2013), ESL flight crewmember ability to adequately read and understand operational procedures and complex vocabulary words/sentence structure can negatively impact ESL flight crewmember competency when they read English language. After the airplane crash investigation of Tatarstan Airlines, the Interstate Aviation Committee (IAC) found that flight crewmember English language proficiency was a factor that influenced the crash. Particularly, the accident investigation team found that the Russian civil aviation authority did not levy requirements for Russian flight crewmembers to read and understand English language, with adequate proficiency levels (IAC 2015). The investigation also revealed that the International Civil Aviation Organization (ICAO) needed to update their English Language Proficiency Requirements (ELPRs) to include reading proficiency in English language. Current ICAO ELPRs address communication when using radiotelephony and ICAO phraseology. A previous aircraft accident in 2012 involving an ATR-72 VP-BYZ indicated a need to design and integrate written English language on operational manuals clearly (IAC 2013). The accident indicated that flight crewmember proficiency levels (ICAO ELPRs) are not the only requirements for proficiency. Flight crewmember reading comprehension of English language is a critical element that can impact their English language proficiency. Furthermore, IAC (2015) report indicated that English language vocabulary words and structure are ambiguous and can lead to misunderstandings. It was indicated that certain flight control procedures followed by flight crewmembers were misunderstood, which was a factor that led to the accident. Finally, the report concluded that flight crewmember English language proficiency was not adequate when they read flight manuals (e.g. Flight Crew Training Manuals), and their proficiency was found to be less than adequate during training.

Western built flight decks are designed to provide alerts and procedures that assist flight crewmembers with decision-making. Goal of designing alerts and procedures is to provide alert style and procedural guidance that corresponds to flight crewmember tasks on the flight deck (e.g. Quick Reference Handbook). Essentially, written English language should be designed and integrated with appropriate format, so that information can be used effectively by crewmembers to complete assigned tasks. According to Barshi et al. (2016), there are four aspects to consider when designing and integrating English language on checklists. These aspects are as follows: (1) consistent utilization of vocabulary words, (2) common word meaning, simple syntax (3) acronym and abbreviation use (4) appropriate vocabulary word use. Consistent utilization of vocabulary words is the process of using common wording on the flight deck. This

provides crewmembers with ability to understand checklist information alongside flight deck terminology. Use of common word meaning provides flight crewmembers with ability to shape their mental model regarding vocabulary words used for particular tasks. Simple syntax can allow flight crewmembers to read and comprehend information in a timely manner. Acronyms and abbreviations are used often on crew alerting and information systems, but they should only be used when flight crewmembers are familiar with the terminology. For example KT is ‘knots’ and FL is ‘flight level’. An example of an acronym is mode control panel ‘MCP’. Confusion can occur between flight crewmembers if abbreviated forms of words and acronyms are used inappropriately. Use of appropriate vocabulary words is related to ensuring proper use of aviation English is standardized on alerts and operational documentation. In other words, information should be clear, concise, and provide the operator with the ability to make informed decisions. Words that are complex to read and understand may impact flight crewmembers’ ability to respond to an alert action. Formatting written English language is also a factor that can influence flight crewmember performance on the flight deck. Barshi et al. (2016) indicated that conditional statements and implementation of warnings and cautions should be designed and integrated on checklists appropriately. Conditional statements often contain words that provide emphasis on actions that need to be completed. On the flight deck, non-normal procedures contain conditional statements that are used by flight crewmembers to determine crew actions needed to resolve issues related to system operations. Conditional statements should be structured in a format that is comprehensible for the user.

Considering previously discussed industry issues related to flight crewmember interaction with English language on the flight deck, what is the impact on ESL flight crewmember ability to read and comprehend written English language during non-normal conditions? What types of written English language impact ESL flight crewmember performance on the flight deck? What is the impact of flight crewmembers’ English language proficiency on their ability to read and comprehend English language on the flight deck? What types of metacognitive strategies do flight crewmembers utilize while reading English language? These questions will be answered throughout literature review analyses and discussions, as well as throughout the researcher’s study.

2 Literature Review

Research on human capabilities and limitations on the flight deck has provided the aviation/aerospace industry with an abundance of data, which has focused on ensuring the flight crewmembers have clear mental models on use of different types of information on the flight deck. As information on the flight deck is provided in different forms, it is important that design and integration of written English language on alerting and information systems (e.g. Electronic Centralized Aircraft Monitor (ECAM)/QRH) is consistent with flight crewmember expectations. Consistency in text corpora design, vocabulary word use, text genre, and sentence syntax are some factors that have the potential to impact ESL flight crewmembers reading comprehension performance. Following literature review provides an overview of factors that can lead

to ESL adult misunderstandings when they read and comprehend English language. The review also provides an understanding of how misunderstandings can impact ESL adult performance in various sociotechnical environments.

According to Nielsen-Bohlman and Institute of Medicine (2004), ability to read and understand English language requires adults to have adequate knowledge, skills, and abilities (KSAs) when reading and comprehending English language. Adults should also have adequate proficiency when reading and comprehending English language. Adult proficiency in English language can lead to adequate reading comprehension performance. Yildiz-Genc (2009) indicated that ESL adults experience difficulties with reading and comprehending English language. Syntax, word meaning, and text genre, are just some of the factors that influence ESL adult ability to read and comprehend English language. What processes or metacognitive strategies do ESL adults utilize to read and understand English language? Metacognition is operationally defined as the way in which an individual understands their cognitive processes. Metacognition helps individuals organize their thoughts/ideas to assess a situation or condition. A study conducted by Yildiz-Genc (2009) utilized 15 ESL adults with intermediate English language proficiency. No time constraint was levied on ESL adults and they used bottom-up and top down strategies to read and comprehend English language. Bottom-up strategy considers how an ESL adult may comprehend information considering a linear text flow. Decoding syntax a feature of bottom up strategy that can be used to decode information in a sentence. Adult English language proficiency and vocabulary knowledge is a factor that influences their ability to read and understand English language. Use of top down-strategy by ESL adults enables them to use previous knowledge to read and understand information in sentence syntax. Adults may use background knowledge of information to help them throughout the reading comprehension process. Results from Yildiz-Genc's (2009) study indicated that when ESL adults used bottom up strategies to read and comprehend English language, vocabulary word meaning challenged them, and they used previous sentences to interpret and connect their ideas to understand information they read. Adults also translated words, sentences, and phrases to understand sentence meaning. Furthermore, they re-read information to help them interpret information in sentences. Finally, top down processing was used their background knowledge to understand sentence meaning and vocabulary words. Hammadou (1991), Lin and Chern (2014) have also indicated that ESL adult use background knowledge understand information in sentences. A study conducted by Fatemi et al. (2014) focused on understanding the effects of ESL adult reading comprehension when they used top down and bottom up strategies. Eighty ESL adults were utilized for the study and each participant was proficient with written English language. The 80 adults were split into two groups (top down strategy/bottom up strategy cognitive styles). Results indicated that participants that used bottom up strategy performed better than participants using top down strategy. These results are likely due to the differences in cognitive reading style. Participants that used top down strategy did not comprehend text in the same way as participants using bottom up strategy. Participants that used bottom up strategy were accustomed to using decoding methods to critically analyze text versus participants that used top down strategy, which were accustomed to using their background knowledge to assess reading and comprehension of information.

Overall, Yildiz-Genc's (2009) and Fatemi et al. (2014) studies reveal that strategy use by ESL adults can be helpful when they read and comprehend English language. Depending on the type of strategy utilized, adults may perform differently based on their ability to read and comprehend information. Adult English language proficiency is a factor that influences type of strategy that adults may utilize. Previously discussed theories could be a potential influence on how ESL flight crewmembers perceive and process English language, through use of strategies. The type of strategy flight crewmembers use could potentially impact their ability to perform when responding to crew alerts and using QRH checklists. Next section provides an overview of how text genre influences adult understanding of information.

Text genre can be a factor that influences ESL adult ability to read and comprehend text/text corpora. Abdul-Hamid and Samuel (2012) studied the impact of scientific text (text related to specific subject matter) on adult reading comprehension. Participant English language proficiency levels were proficient or less than proficient. Overall goal of the study was to determine if reading difficulty was observed between participants when they read two different types of scientific texts. Participants had background knowledge of the texts they read, however there were text corpora that had a percentage of vocabulary words that had the potential to be unfamiliar to participants. First text contained 592 words and the other text contained 744 words. Academic words and scientific words were observed combined in each of the texts. Academic words can be more common in text and are part of the Academic Word List (AWL) rather than scientific words. Scientific text/technical text can be found in information that is specific to a particular industry (i.e. nuclear industry). Participants highlighted words they were unfamiliar with in the text they read. Omission of words was observed in the study as well as re-reading text for reading comprehension purposes. Results indicated that participants' proficiency level could have been a factor that led to their difficulties reading text. Park (2010) focused on a study that measured the effects of expository text (cause and effect) on ESL adult reading comprehension. The study contained 115 participants and they were studying English language for academic credit, with a focus on engineering and science. All participants had approximately 10 years of experience with using English language, and many of the participants had experience with English language in different regions of the globe such as United States of America. Many participants self rated themselves as having adequate knowledge of English language and some indicating somewhat adequate knowledge of English language. When participants self rate their English language proficiency it can provide details on how they interpret English language and challenges they may experience (Yeh and Genter 2005). Results from Park's (2010) study indicated participants had strong use of metacognitive strategies when they read expository text with a technical emphasis versus novel text. Participants highlighted text and re-read text for reading comprehension purposes. Rouhi et al. (2015) and Storch (2001) indicated that highlighting information in expository text is an indication that the ESL reader understands the structure (cause and effect). They also indicated that background knowledge in the subject is important when reading expository text. There was also a low-cohesion factor (explanations are less perceptible in the structure of text) in novel text rather than expository text.

Overall, Abdul-Hamid and Samuel (2012) and Park (2010) provide evidence that text genre can influence reading comprehension. Studies also revealed that when adults

self rate themselves on their English language proficiency, this is an adequate indicator of their proficiency level. Adult experience with use of English language and metacognitive strategies are indicators that explain adult reading comprehension abilities. Previously discussed studies reveal the need to further research effects of ESL flight crewmembers use of crew alerting systems and QRH checklists during non-normal conditions. There is a potential that text genre could be different on QRH checklists, and flight crewmember ability to understand different types of text genre may influence their reading comprehension performance. For example, what is the impact to flight crewmembers that do not have adequate experience with use of English language on alert systems and QRH checklists? Does their proficiency level impact their ability to read and understand English language on alert systems and QRH checklists? These factors will be further discussed in the researcher's study.

You (2009) developed a study that focused on ESL adult ability to read and comprehend information on computer screens versus paper format. Two texts that were familiar and unfamiliar were utilized for the experiment design. Participant proficiency levels were low, medium, or high. Text length was 340 words and each of the readings was expository text genre. Results indicated that participants performed satisfactory. Participant background knowledge was better when they read English language from paper rather than computer screen. Participants were more accustomed to reading information on paper and using metacognitive strategies rather than on computer screen. Participants with medium and high proficiencies performed better reading text in the same format, rather than participants that read text in a different format. A study conducted by Park et al. (2014) focused on English language abbreviations. Seven participants from different regions of the globe had an English language proficiency of satisfactory. Two participants had technical background knowledge, while the other participants had academic/business knowledge. Participants had experience using English language in the United States and had knowledge of the text they read. Results indicated that acronyms were difficult to read and background knowledge was used to understand acronyms. Participants also utilized dictionary sources to understand the acronyms.

You (2009) and Park et al. (2014) studies indicate that text length and abbreviated text have an impact on how well ESL adults read and understand English language. Adult proficiency levels and technical background knowledge are factors that also influence how well adults read and interpret English language. Both authors indicated that use of metacognitive strategies by adults is influenced by level of English language proficiency. On the flight deck, ESL flight crewmembers use alert systems and checklists; therefore vocabulary words and checklist items should be adequately designed so they may be interpreted well by flight crewmembers. As many flight crewmembers may use background knowledge of English language from training or experience using English language, design and integration of information on checklists and alert systems must be written so they are understood from a variety of flight crewmembers with different linguistic backgrounds.

The literature review provided an overview of factors that influence ESL adult ability to read and understand written English language in socio-technical

environments. Design and integration of English language has potential to impact adult performance. In particular, background knowledge of text is a factor that impacts adult ability to read and understand information. Adult proficiency level influences metacognitive strategy use and amount of metacognitive strategies utilized to read and interpret information. The type of words used in text corpora (i.e. academic words, technical words), influence adult reading and comprehension of information. On the flight deck, ESL flight crewmembers English language proficiency level, background knowledge, metacognitive strategy, variation of strategies utilized, and experience using English language, can influence how well flight crewmembers read and interpret information. It can also impact how they respond to non-normal conditions on the flight deck. The next sections provide an overview of the impact of ESL flight crewmember use of written English language on the flight deck.

3 Methods

A qualitative research study was conducted with 19 ESL flight crewmembers. Term flight crewmember is also known as roles captain/first officer. Each flight crewmember had experience flying large transport category aircrafts, such as the Embraer Regional Jet (ERJ). Flight crewmembers had Air Transport Pilot (ATP) ratings. All flight crewmembers had experienced with English language throughout their initial schooling (e.g. grade school) and secondary school—college education. For the purposes of this study, flight crewmembers' English language experience was considered background knowledge. The ICAO ELPRs level ratings were between four and six. Level four is considered operational use of English language and level six is more the satisfactory use of English language. Even though flight crewmember ICAO ELPRs level ratings are related to flight crewmember communication while using radiotelephony, the data was collected to understand influences that may impact flight crewmember background knowledge of English language. Flight crewmember reading comprehension levels were collected to understand how well they read and comprehend written English language. Each of the 19 flight crewmembers rated themselves on their general use of English language (command of English language in non-socio-technical environments), and proficiency when they read and comprehend written English language on alerts and the QRH on the flight deck (i.e. technical information on the flight deck). Flight crewmember proficiency levels were considered Reading Comprehension Levels (RCLs). Flight crewmember proficiency levels were either rated as low-intermediate (L-I), intermediate (I), or high-level (H). Low-intermediate English language proficiency indicated flight crewmember understanding of English language was adequate, but they had issues with sentence syntax and words. Flight crewmembers with intermediate-level proficiency indicated they required more knowledge of English language. Flight crewmembers with High-level English language proficiency indicated they were comfortable with reading and comprehending written English language. The following demographics were provided for the study (Tables 1, 2 and 3):

Table 1. Flight crewmember Demographics (N = 19)

Demographics	Pilot 1	Pilot 2	Pilot 3	Pilot 4	Pilot 5	Pilot 6	Pilot 7	Pilot 8
Country of origin	Ecuador	Ecuador	Ecuador	Ecuador	Brazil	Brazil	Ecuador	Trinidad
Age	53	32	43	29	34	50	37	51
Airline years of experience	15	8	11	4.5	10	6	10	8
Native language spoken	Spanish	Spanish	Spanish	Spanish	Portuguese	Portuguese	Spanish	Caribbean Dialect
English language learned/country	Grade School/ Ecuador	Grade School/ Ecuador	Grade School/ U.S.	University/ U.S.	University/ South America	University/ U.S.	University/ U.S.	University/ Trinidad
ICAO ELPR level	Level 6	Level 6	Level 6	Level 6	Level 4	Level 4	Level 5	Level 6
Self-rated English language RCL (General use of English language)	I-Level	I-level	I-Level	I-Level	I-Level	H-Level	H-Level	H-Level
Self-rated RCL: English language on crew alerting systems and QRH checklists	I-Level	I-Level	H-Level	L-I Level	L-I Level	H-Level	I-Level	H-Level

Table 2. Flight crewmember Demographics (N = 19)

Demographics	Pilot 9	Pilot 10	Pilot 11	Pilot 12	Pilot 13	Pilot 14	Pilot 15	Pilot 16
Country of origin	Brazil	Brazil	Brazil	Brazil	Jordan	Jordan	Jordan	Jordan
Age	36	28	45	41	32	25	38	28
Airline years of experience	12	6	17	11.5	3	2	13	3
Native language spoken	Spanish	Spanish	Spanish	Spanish	Arabic	Arabic	Arabic	Arabic
English language learned/country	Grade school/ secondary/ U.S.	Secondary school/ U.S.	Secondary school/ U.S.	Secondary school/ U.S.	Pre-school/ Jordan	Pre-school/ Jordan	Pre-school/ U.S.	Pre-school/ Jordan
ICAO ELPR Level	Level 4	Level 4	Level 4	Level 4	Level 5	Level 5	Level 6	Level 6
Self-rated English language RCL (General use of English language)	I-Level	I-Level	I-Level	H-Level	H-Level	H-Level	H-Level	H-Level
Self-rated RCL: English language on crew alerting systems and QRH checklists	L-I level	L-I Level	H-Level	L-I Level	H-Level	H-Level	H-Level	H-Level

Most flight crewmembers country of origin was Brazil. Second most frequent country of origin was Ecuador, followed by Jordan. Trinidad, United States of America (USA), Bulgaria, and Colombia were also flight crewmembers country of origin. Average age was 36 years old. Flight crewmembers most common spoken language was Spanish, Arabic, Portuguese, Caribbean dialect, and Bulgarian. The researcher led face-to-face interviews with 19 flight crewmembers. Data from interviews was

Table 3. Flight crewmember Demographics (N = 19)

Demographics	Pilot 17	Pilot 18	Pilot 19
Country of origin	Colombia	U.S.	Bulgaria
Age	22	26	37
Airline years of experience	4	1	4
Native language spoken	Spanish	Spanish	Bulgarian
English language learned/country	University/ U.S.	Pre-school/ U.S.	Pre-school/University as exchange student in U.S.
ICAO ELPR Level	Level 5	Level 5–6	Level 6
Self-rated English language RCL (General use of English language)	I-Level	I-Level	H-Level
Self-rated RCL: English language on crew alerting systems and QRH checklists	I-Level	I-Level	H-Level

recorded, coded, and themes were established based on the data. Researcher developed a questionnaire to collect data on flight crewmember performance when they read and comprehend information on alert systems and QRH checklists. Questionnaire focused on flight crewmember self rated reading comprehension proficiency levels, background knowledge of English language, and metacognitive strategies flight crewmembers utilized when they read and comprehend English language on alerting systems and QRH checklists. Follow-up discussions between the researcher and flight crewmembers were conducted. Researcher's coding method will be described in a future section.

4 Limitations

Information collected from surveys was generic to alerting systems and QRH checklists. The study did not measure flight crew performance, with respect to their ability to interpret vocabulary words and text genre, and measurement of workload when they read and comprehend written English language. These types of variables limited the scope of the researcher's study.

5 Coding Method

Researcher utilized a transcription template that consisted of coding information collected from interviews held between the researcher and flight crewmembers, and questionnaires that flight crewmembers completed. Coding schema was related to flight crewmember demographics, related to their ability to read and comprehend English language, background knowledge, English language proficiency (reading comprehension level), metacognitive strategies, crew alerting design/integration factors, and QRH checklist design/integration factors. Flight crewmember performance and flight safety related impacts were also coded.

6 Inter-rater Reliability

Researcher consulted two flight systems experts to review coding from interviews and questionnaires. Their background was in system safety and ESL flight crewmember performance. Experts used the previously discussed coding schema to determine if they could code information from the interviews and questionnaires and determine level of agreement. Results showed that there was substantial inter-rater reliability ($k = 1$).

7 Results

Results from the interviews and questionnaires indicated flight crewmembers noted several challenges with their ability to read and comprehend information on alert and information systems. High percentage of flight crewmembers indicated they use metacognitive strategies to read and interpret English language on alert systems and QRH checklists. Flight crewmembers noted that when they read and comprehend information on QRH checklists/alert systems together to solve system errors on the flight deck, their reading comprehension was negatively impacted. Flight crewmembers also indicated flight safety was impacted as a result of their ability to read and comprehend information on alerts and QRH checklists. Next results provide a review of flight crewmember self rated RCLs (proficiency levels), including their general use of English language and use of English language on alert systems and QRH checklists. Additionally, flight crewmember background knowledge factors, vocabulary words/text genre knowledge, metacognitive strategies use, and proficiency level results are provided (Table 4).

Table 4. English language proficiency factors

Description	Flight crewmembers percentage
Self rated English language proficiency RCL of general use of English language (L-I)	0/19 (0%)
Self rated English language proficiency RCL of general use of English language (I)	10/19 (~ 53%)
Self rated English language proficiency RCL of general use of English language (HL)	9/19 (~ 47%)
Self rated English language proficiency RCL of English language on crew alerting systems and QRH checklists (L-I)	5/19 (~ 26%)
Self rated English language proficiency RCL of English language on crew alerting systems and QRH checklists (I)	5/19 (~ 26%)
Self rated English language proficiency RCL of English language on crew alerting systems and QRH checklists (HL)	9/19 (~ 47%)

Flight crewmembers had a variety of written English language proficiency levels with respect to their RCL of general English language, alerting systems and QRH checklists (Table 5).

Table 5. Flight crewmember Background knowledge factors

Description	Flight crewmembers percentages
English language-ICAO ELPR Level 4, 5, 6	19/19 (100%)
Preliminary School (Grade School) non-western region experience reading and speaking English language	3/19 (~ 16%)
Preliminary School (Grade School) western region experience reading and speaking English language	7/19 (~ 37%)
Secondary School (University) non-western region experience reading and speaking English language	0/19 (0%)
Secondary School (University) western region experience reading and speaking English language	9/19 (~ 47%)
ATP Certification (ability to read English language)	19/19 (100%)
Airline years of experience using crew alerting systems and QRH checklists	19/19 (100%)

Flight crewmember ICAO proficiency levels were between 4–6. All flight crewmembers had an ATP certification and years of experience using alerting systems and QRH checklists. Flight crewmember English language experience was different with respect to institution type and western/non-western regions (Table 6).

Table 6. Flight crewmember Vocabulary Words/Text Genre Background knowledge factors

Description	Flight crewmembers percentage
Knowledge of English language text genre on crew alerting systems (e.g. technical text)	19/19 (100%)
Knowledge of English language text genre on QRH checklists (e.g. technical text)	19/19 (100%)
Knowledge of English language elements on QRH checklists (e.g. typographical elements)	19/19 (100%)
English language experience with conditional statements on QRH checklists (e.g. structure, noticing)	19/19 (100%)
Background knowledge of abbreviations/acronyms (e.g. short form and/or long form)	19/19 (100%)
Background knowledge of text format on crew alerting systems and QRH Checklists (e.g. authentic, elaborated, or short text)	19/19 (100%)
ATP certification (knowledge of crew alerting systems/QRH checklists)	19/19 (100%)
Background knowledge of vocabulary word type on crew alerting systems	19/19 (100%)
Background knowledge of vocabulary word type on QRH checklists	19/19 (100%)

Flight crewmembers had experience with vocabulary words and text genre background on alerting systems and QRH checklists (Tables 7 and 8).

Table 7. Flight crewmember metacognitive strategy use and proficiency level factors

Description	Flight crewmembers percentage	Flight crewmembers English language proficiency and percentage (RCL proficiency general English language)	Flight crewmembers English language proficiency and percentage (crew alerting systems and QRH checklists RCL proficiency)
Re-reading text	10/19 (~ 53%)	~ 32% I-level; ~ 21% H-Level	~ 21% I-level; ~ 21% L-I level; 11% H-level
Paraphrasing text	0/19 (0%)	N/A	N/A
Underlining text	2/19 (~ 11%)	~ 11% I-Level	~ 11% L-I Level
Referencing other Resources to clarify information (e.g. dictionary)	1/19 (~ 5%)	~ 5% H-Level	~ 5% H-Level
Highlighting text	1/19 (~ 5%)	~ 5% I-Level	~ 5% L-I Level
Translating written English language into ESL flight crewmembers native language	4/19 (~ 21%)	~ 5% I-Level; ~ 16% H-Level	~ 5% I-Level; ~ 16% H-Level
Reverting back to native language to read English language	4/19 (~ 21%)	~ 21% I-level	~ 5% I-Level; ~ 16% H-Level
Reading aloud text on flight deck	2/19 (~ 11%)	~ 5% I-Level; ~ 5% H-Level	~ 11% H-Level

Table 8. Flight crewmember metacognitive strategy use and proficiency level factors continued

Description	Flight crewmembers percentage	Flight crewmembers English language proficiency and percentage (RCL proficiency general English language)	Flight crewmembers English language proficiency and percentage (crew alerting systems and QRH checklists RCL proficiency)
Monitoring reading comprehension	1/19 (~ 5%)	~ 5% H-level	~ 5% H-level
Taking notes	2/19 (~ 11%)	~ 11% I-level	~ 11% L-I level
Breaking apart sentences	3/19 (~ 16%)	~ 11% I-level; ~ 5% H-level	~ 5% L-I level; ~ 11% H-level
Bottom up strategy (decoding text)	3/19 (~ 16%)	~ 5% I-level; ~ 11% H-level	~ 5% I-level; 11% H-level

(continued)

Table 8. (continued)

Description	Flight crewmembers percentage	Flight crewmembers English language proficiency and percentage (RCL proficiency general English language)	Flight crewmembers English language proficiency and percentage (crew alerting systems and QRH checklists RCL proficiency)
Top down strategy (prior knowledge of text; activating text schema)	5/19 (~26%)	~11% I-level; ~16% H-level	~5% L-I level; ~5% I-level; ~16% H-level
Interactive strategy (combination of bottom up and top down strategy use)	4/19 (~21%)	~5% I-level; ~16% H-level	~5% I-level; ~16% H-level
Monitoring reading speed	2/19 (~11%)	~5% I-level; ~5% H-level	~5% H-level; ~5% H-level
Skipping words/ omission of words	2/19 (~11%)	~11% I-level	~5% H-level; ~5% L-I level

Flight crewmembers utilize different metacognitive strategies to read and comprehend written English language. Flight crewmember metacognitive strategy use and English language proficiency levels were different when they read and interpret written English language (Tables 9 and 10).

Table 9. Crew alerting system design and integration factors as indicated by flight crewmembers

Description	Flight crewmembers Percentage	Flight crewmembers English language proficiency and percentage (RCL proficiency general English language)	Flight crewmembers English language proficiency and percentage (crew alerting systems and QRH checklists RCL proficiency)
Sentence length (short)	0/19 (0%)	N/A	N/A
Acronyms/abbreviations	6/19 (~32%)	~16% I-level; ~16% H-level	~16% I-level; ~16% H-level
Text genre (e.g. technical)	9/19 (~47%)	~32% I-level; ~16% H-level	~21% I-level; ~21% H-level; ~5% L-I level
Number of tokens in text	0/19 (0%)	N/A	N/A

Table 10. Crew alerting system design and integration factors as indicated by flight crewmembers continued

Description	Flight crewmembers percentage	Flight crewmembers English language proficiency and percentage (RCL proficiency general English language)	Flight crewmembers English language proficiency and percentage (crew alerting systems and QRH checklists RCL proficiency)
Authentic text	9/19 (47%)	~32% I-level; ~16% H-level	~21% I-level; ~21% H-level; ~5% L-I level
Sentence length (long)	1/19 (~5%)	~5% I-level	~5% I-level
Simplification of text	1/19 (~5%)	~5% I-level	~5% H-level
Vocabulary words type	5/19 (~26%)	~26% I-level	~11% I-level; ~11% H-level; ~5% L-I level

Flight crewmembers indicated several different written English language design and integration factors influenced their ability to read and interpret information on alerting systems. Flight crewmember English language proficiency level indicated differences with respect to English language design and integration factors that negatively impacted flight crewmember reading comprehension of English language on crew alerting systems (Table 11).

Table 11. QRH checklist design and integration factors as indicated by flight crewmembers

Description	Flight crewmembers Percentage	Flight crewmembers English language proficiency and percentage (RCL proficiency general English language)	Flight crewmembers English language proficiency and percentage (crew alerting systems and QRH checklists RCL proficiency)
Conditional statements	3/19 (~16%)	~11% I-level; ~5% H-level	~5% L-I-level; ~5% I-level; ~5% H-level
Number of token in text	3/19 (~16%)	~11% I-level; ~5% H-level	~11% L-I level; ~5% H-level
Authentic text	17/19 (~89%)	~47% I-level; ~42% H-level	~26% I-level; ~26% L-I level; ~37% H-level

(continued)

Table 11. (continued)

Description	Flight crewmembers Percentage	Flight crewmembers English language proficiency and percentage (RCL proficiency general English language)	Flight crewmembers English language proficiency and percentage (crew alerting systems and QRH checklists RCL proficiency)
Sentence length (long)	5/19 (~26%)	~16% I-level; ~11% H-level	~11% L-I level; ~11% H-level; ~5% I-level
Simplification of text	1/19 (~5%)	~5% H-level	~5% H-level
Acronyms/abbreviations	4/19 (~21%)	~11% I-level; ~11% H-level	~16% I-level; ~5% H-level
Text genre (e.g. technical)	17/19 (~89%)	~47% I-level; ~42% H-level	~26% I-level; ~26% L-I level; ~37% H-level
Vocabulary words type	14/19 (~74%)	~42% I-level; ~31% H-level	~16% I-level; ~26% L-I level; ~31% H-level
Sentence length (short)	0/19 (0%)	N/A	N/A

Flight crewmembers indicated several different written English language design and integration factors that impacted their ability to read and interpret information on QRH checklists. Flight crewmember English language proficiency levels indicated differences with respect to English language design and integration factors that negatively impacted their reading comprehension of English language on QRH checklists (Table 12).

Table 12. Flight safety impact factors as indicated by flight crewmembers

Main theme: ESI flight crewmembers flight safety impact	Percentages	Flight crewmembers English language proficiency and percentage (RCL proficiency general English language)	Flight crewmembers English language proficiency and percentage (crew alerting systems and QRH checklists RCL proficiency)
Improper system diagnosis - Difficulty understanding abbreviations and acronyms	1/19 = ~5%	~5% I-level	~5% I-level

(continued)

Table 12. (continued)

Main theme: ESI flight crewmembers flight safety impact	Percentages	Flight crewmembers English language proficiency and percentage (RCL proficiency general English language)	Flight crewmembers English language proficiency and percentage (crew alerting systems and QRH checklists RCL proficiency)
Long processing time of information -Due to translation of words into native language, highlighting/underlining words on checklists - Due to decoding abbreviations	10/19 = ~52%	~31% I-level; ~21% H-level	~5% I-level; 21% L-I level; ~26% H-level
Workload impact - Very detailed QRH checklists - Challenging vocabulary words	5/19 = ~26%	~16% H-level; ~11% I-level	~21% H-level; ~5% L-I level
Frustration - Very detailed QRH checklists - Unknown words	1/19 = 5%	~5% H-level	~5% L-I level
Omission and misinterpretation of information - Skipping words due to misunderstanding - Reverting back to native language	2/19 = ~11%	~5% I-level; ~5% H-level	~5% H-level; ~5% I-level

Regarding flight crewmember English language proficiency levels, each flight crewmember indicated different proficiency levels with respect to their performance factors that negatively impacted flight safety.

8 Discussion

Previous literature indicated that ESL adult background knowledge of English language, knowledge of text genre/vocabulary words, and English language proficiency are key components to understand how well adults may read and comprehend written English language. The researcher's study indicated that all flight crewmembers had background knowledge of English language. They received English language

instruction from a variety of educational institutional learning systems (e.g. university education). Many flight crewmembers had western region experience with English language (grade school and university) Flight crewmembers also had airline years of experience using written English language on crew alerting systems and QRH checklists. Therefore, flight crewmembers had background of vocabulary words/text genre background. Flight crewmembers' ATP ratings were utilized, as it was an indication they were able to read English language on the flight deck. As ECFR (2016) indicated, ATP rating is common for ESL airline flight crewmembers and is an indication that flight crewmembers must be able to read English language. The ICAO level of English language proficiency data collected indicated that all flight crewmembers met minimum requirements for ELPRs and some exceeded the requirements (ICAO 2004). Although flight crewmember ICAO ELPR levels were level four, five, and six, these levels do not provide an indication of how well flight crewmembers read and comprehend written English language. The IAC (2013) indicated that ESL flight crewmember ICAO ELPRs are not enough to assess how well flight crewmembers read and comprehend written English language. Therefore, self-rated English language proficiency levels were utilized and indicated each flight crewmember had different English language proficiency RCL with respect to their general English language reading comprehension. Additionally, flight crewmembers had dissimilar English language proficiency RCL reading and comprehending written English language on crew alerting systems and QRH checklists. Recall, utilization of ESL adult self-proficiency ratings are important, as they provide indicators of adults metacognitive strategy use, and how well they read and comprehend written English language on technical information, especially expository and instructional texts (Park 2010; Yeh and Genter 2005). Technical information was noted as challenging to many flight crewmembers regardless of the metacognitive strategy they utilized to read and understand written English language. Their use of metacognitive strategies to read and comprehend written English language on crew alerting systems and QRH checklists were different, and proficiency levels (general English language, crew alerting systems and QRH checklists) varied based on use of either crew alerting systems and/or QRH checklists. Regarding metacognitive strategy use by flight crewmembers, strategies utilized on QRH checklists (paper format) were different than crew alerting systems (displayed format). As Holder (2003) indicated, flight crewmember English language proficiency has the potential to be different based on their use of each of these systems (i.e. crew alerting systems and QRH checklists). Collectively, flight crewmembers' English language proficiency influenced their ability to read and comprehend written English language. Flight crewmembers had various English language proficiency levels, and each flight crewmember proficiency level influenced their ability to read information on crew alerting systems and QRH checklists. Altogether, aforementioned aspects were fundamental requirements needed to assess how well flight crewmembers read and understand written English language on crew alerting systems and QRH checklists, and challenges they experienced reading technical information. Next sections provide detailed discussions on the researcher's study.

As Smith-Jackson (2006) and Riley et al. (2006) indicated, understanding differences in flight crewmember cognitive processing of written English language is important, especially factors that may impact their performance. Written English

language on crew alerting systems and QRH checklists should be evaluated, with respect to flight crewmembers cognitive ability to read and understand written English language on each of the systems (Burian 2006 and Holzinger et al. 2011). With respect to metacognitive strategies use by flight crewmembers, the researcher's study indicated differences in type of strategy utilized, number of metacognitive strategies utilized, and most common/least common strategy utilized to read and comprehend written English language. Most flight crewmembers utilized at least one metacognitive strategy to read and understand written English language, and there were many flight crewmembers with RCL proficiency H-level (general English language, crew alerting systems and QRH checklists) that utilized many metacognitive strategies to read and understand written English language on crew alerting systems and QRH checklists. As Park's (2010) study indicated, high self-rated proficiency ESL adults utilize more metacognitive strategies. On the other hand, in the researcher's study flight crewmembers with RCL proficiency I-level (general English language, crew alerting systems and QRH checklists) also utilized many metacognitive strategies. It was indicated that flight crewmembers with RCL proficiency I-level were also comfortable with using strategies to read written English language. Flight crewmembers with RCL proficiency L-I level indicated they utilized strategies to help guide them through the reading comprehension process. Anderson (2004) indicated that ESL adults read and interpret written English language utilizing mental models. In the researcher's study, flight crewmembers (sixteen percent) utilization of bottom up strategy (decoding text) was found. As Liu (2014) indicated, use of this model is dependent on ESL adult English language proficiency. Likewise, flight crewmembers (eleven percent) with RCL proficiency H-level and five percent with RCL proficiency I-level (general English language) use bottom up strategy (decoding text), while flight crewmembers (eleven percent) with RCL proficiency H-level and flight crewmembers (five percent) with RCL proficiency I-level (crew alerting systems, QRH checklists) utilize bottom up strategy (decoding text). It was indicated that flight crewmembers with RCL proficiency H-level had background knowledge of decoding words on crew alerting systems and QRH checklists. Additionally, flight crewmembers with RCL of H-level proficiency indicated they were comfortable using this strategy to read and understand written English language on crew alerting systems and QRH checklists. Use of top down strategy (background knowledge) by twenty-six percent of flight crewmembers was utilized more than bottom up strategy to activate their background knowledge/content schema of written English language text, on crew alerting systems and QRH checklists. Use of background knowledge by ESL adults to read and interpret English language is typical as indicated by Lin and Chern (2014), Hammadou (1991). In the researcher's study, flight crewmembers indicated they utilized English language skills they learned from their airline as mechanisms to read and understand written English language on crew alerting systems and QRH checklists. They considered their years of experience as an indicator of background knowledge of English language as well as the different types of checklists containing different layouts of technical information. Comparable to the flight crewmembers with RCL proficiency H-level that utilized bottom up strategy to read and understand written English language, flight crewmembers with RCL proficiency H-level also utilize top down strategy more than flight crewmembers with RCL proficiency I-level and L-I level. Flight crewmembers (sixteen percent) with RCL

proficiency H-level utilize top down strategy, while eleven percent of flight crewmembers with RCL proficiency I-level (general English language) use top down strategy. On the other hand, flight crewmembers (sixteen percent) with RCL proficiency H-level, five percent I-level, and five percent L-I level (crew alerting systems, QRH checklists) use top down strategy. Flight crewmembers with RCL proficiency H-level indicated they were comfortable with written English language on crew alerting systems and QRH checklists because they were able to utilize their background knowledge of the systems. This finding is consistent with Yildiz-Genc's (2009) and You's (2009) study which indicated that background knowledge and familiarity with written English language indicates that ESL adults will read and understand written English language better than text that is unfamiliar to them. Twenty-one percent of flight crewmembers' indicated they use interactive strategy. Flight crewmembers (sixteen percent) were RCL proficiency H-Level and five percent were I-level (general English language), while flight crewmembers (sixteen percent) with RCL proficiency H-level and five percent I-level (crew alerting systems, QRH checklists) use interactive strategy. Flight crewmembers indicated that use of this strategy was due to their ability to decode and use background knowledge on sections of the QRH checklists. This finding is consistent with Fatemi et al.'s (2014) study. Flight crewmembers also indicated that familiarity with checklists items helped them recognize certain pieces of text. Re-reading text on crew alerting systems and QRH checklists was considered a strategy utilized by most flight crewmembers (fifty-three percent). Flight crewmembers (thirty-two percent) with RCL proficiency I-level and twenty-one percent of flight crewmembers with RCL proficiency H-level (general English language) utilized re-reading text strategy. Twenty-one percent of flight crewmembers that were RCL proficiency L-I level and twenty-one percent that were I-level use re-reading text strategy, while eleven percent of flight crewmembers with RCL proficiency H-level (crew alerting systems, QRH checklists) use re-reading text strategy. Flight crewmembers with RCL proficiency H-level indicated they only re-read text, if they did not understand information on checklists. On the other hand, flight crewmembers with RCL proficiency level I-level and L-I level indicated they re-read information to have a clearer picture of the system issue. In other words, flight crewmembers with RCL proficiency I-level and L-I level re-read checklist information as a practice to ensure they understood information, whereas, flight crewmembers with RCL proficiency H-level, only re-read information if they misinterpreted a word or sentence on a checklist. Flight crewmembers with RCL proficiency H-level indicated that sometimes very detailed checklists require certain words to be re-evaluated/re-interpreted. As Yildiz-Genc (2009) indicated, intermediate level ESL adults were more inclined to re-read sentences to understand the meaning. In the researcher's preliminary study flight crewmembers with RCL I-level indicated they re-read information as a common practice, not just to understand word or sentence meaning. Twenty-one percent of flight crewmembers' translate written English language on QRH checklists into their native language. Sixteen percent of flight crewmembers had RCL proficiency H-level and five percent I-level (general English language), while sixteen percent of flight crewmembers with H-level and five percent I-level (crew alerting systems, QRH checklists) translate written English language on QRH checklists back into their native language. As Hutchins et al. (2006, p. 5) indicated, "certain words may not be translated adequately

and could destroy word meaning". In the researcher's study, long processing time of information was due to translation of checklists words and sentences into their native language. As Abdul-Hamid and Samuel (2012) indicated, translation of written English language into their native language led to ESL adults re-reading sentences. This was not the case in the researcher's study, rather flight crewmembers' reading time was long due to processing translated written English language words into their native language. They indicated they utilize translation strategy because their airline uses the strategy often to understand written English language on crew alerting systems and QRH checklists. Interestingly, ESL adult proficiency levels in Abdul-Hamid and Samuel (2012) study were either proficient or less than proficient. In the researcher's study, flight crewmembers' RCL proficiency was H-level or I-level, there were no flight crewmembers that translated written English language text, with RCL proficiency of L-I level. Therefore, the researcher's finding does not support this aspect of Abdul-Hamid and Samuel (2012) study, which indicated that less than proficient adults were negatively impacted by translation process. Twenty-one percent of flight crewmembers indicated they use reversion back to their native language strategy to understand written English language on crew alerting systems. Twenty-one percent of flight crewmembers with RCL proficiency I-level (general English language) indicated they use reversion strategy, while sixteen percent of flight crewmembers with RCL proficiency H-level and five percent I-level (crew alerting systems and QRH checklists) use reversion strategy. Flight crewmembers indicated they use this strategy as a common practice at their airline. As Kobayashi and Rinnert (1992) indicated, reverting back to English language can occur because ESL adult lack of understanding translated syntax meaning. This can result in inappropriate translation of technical information back into their native language. In the researcher's study, flight crewmembers' indicated they utilized this strategy because some aviation abbreviations and words are the same definition and are written fairly the same. Familiarity with words in their native language helps them as they process words on crew alerting systems when they use reversion strategy. As Larsen and Hansen (2010) indicated abbreviations and acronyms that are found in certain genres of text aid ESL adults with understanding their meaning due to their familiarity with the text. Additionally, this strategy did not lead flight crewmembers to incorrect translation of words into their native language. Referencing other resources to help clarify information (e.g. dictionary) was a strategy utilized by five percent of flight crewmembers. A flight crewmember with RCL proficiency H-level (general English language, crew alerting systems and QRH checklists) uses referencing other resources strategy to read written English language on crew alerting systems and QRH checklists. Five percent of flight crewmembers' use highlighting text strategy on QRH checklists. The flight crewmember had RCL proficiency I-level (general English language) and L-I level (crew alerting systems and QRH checklists). Flight crewmembers' (eleven percent) utilize taking notes strategy. Eleven percent of flight crewmembers' proficiency levels were RCL proficiency I-level (general English language) and L-I level (crew alerting systems and QRH checklists). According to Park's (2010) study, there were many ESL adults that utilized referencing and highlighting strategies to read and comprehend written English language text. In Park's (2010) study, note taking was the least utilized strategy. Additionally, Park's (2010) study indicated that more ESL adults had fairly good or not adequate English language

proficiency, than high English language proficiency level ESL adults (English speaking and reading comprehension abilities). Contrary to Park's (2010) study, the researcher's preliminary study indicated that referencing and highlighting strategies were utilized the least by flight crewmembers with RCL of H-level, I-level, and L-I level (general English language, crew alerting systems and QRH checklists). Note taking strategy was not utilized the least by flight crewmembers, it was utilized more than referencing and highlighting text to read and interpret written English language on checklists. They indicated note taking helped them remember words they may see again on QRH checklists. Whereas, referencing and highlighting were indicated as a strategy utilized to access information on the checklists when they had a system malfunction/failure in an aircraft they flew. Monitoring reading comprehension was utilized by five percent of flight crewmembers. A flight crewmember with RCL H-level (general use of English language, crew alerting systems and QRH checklists) indicated use of monitoring reading comprehension strategy. Whereas, monitoring reading speed was commonly utilized by eleven percent of flight crewmembers. A flight crewmember with RCL proficiency I-level and a flight crewmember with H-level (general English language) use monitoring reading speed strategy. Both flight crewmembers indicated their RCL proficiency levels were H-level (crew alerting systems and QRH checklists). As Park's et al. (2014) study revealed, ESL adults with very good English language proficiency utilized monitoring reading comprehension to read and comprehend written English language. Part of Park's et al. (2014) study was corroborated in the researcher's preliminary study. One flight crewmember with high English language proficiency utilized monitoring reading comprehension to read written English language on QRH checklists. It was indicated that this was a practice the flight crewmember utilized to help set his expectations on the type of information he was about to read. Monitoring reading speed strategy was not indicated in Park's et al. (2014) study, but was utilized as a strategy by two flight crewmembers with high and intermediate level of English language proficiency in the researcher's preliminary study. Eleven percent of flight crewmembers' used skipping/omission of words on crew alerting systems and QRH checklists. Each flight crewmember (eleven percent) had RCL proficiency I-level (general English language), while eleven percent of flight crewmembers had RCL proficiency H-level and L-I level (crew alerting systems, QRH checklists). Each flight crewmember indicated they utilized skipping and omission of words if they did not understand written English language text. As Dordick (1996) indicated omission of words is due to ESL adults misunderstanding words, or unfamiliar words in text. As this was the case in the researcher's study, this strategy was also utilized by flight crewmembers with different levels of English language proficiency. As Abdul-Hamid and Samuel (2012) study revealed, ESL adults that were proficient with English language and less than proficient utilize skipping/omission strategy to understand written English language. Sixteen percent of flight crewmembers that utilize breaking apart sentences had a variety of RCL proficiency levels. Eleven percent of flight crewmembers with RCL proficiency I-level and five percent H-level (general English language) use breaking apart sentences strategy. On the other hand, five percent of flight crewmembers with RCL proficiency L-I level and eleven percent of flight crewmembers with RCL proficiency H-level (crew alerting systems, QRH checklists) indicated they utilized breaking apart sentences strategy. It was indicated that they use

this strategy if they were unfamiliar with text or text seemed to be longer than expected on QRH checklists. Part of this finding is corroborated in Anderson (2003) study. In Anderson's (2003) study, it was indicated that intermediate level ESL adults utilized breaking apart sentences to understand written English language text. The researcher's study revealed that flight crewmembers with RCL proficiency H-level, L-I level, and I-level utilized breaking apart sentences to read and understand text on QRH checklists. Flight crewmembers (eleven percent) utilize underlining text on QRH checklists and had RCL proficiency of I-level and L-I level (general English language, crew alerting systems and QRH checklists). Flight crewmembers' indicated they utilized underlining strategy if they were unfamiliar with text, and if time permitted would go back and review the meaning of the word during a period of time that was not congested with other tasks. They also indicated they underlined text if it was unfamiliar to them in their native language. This finding is different from Rouhi et al. (2015) and Storch (2001) studies. They suggested highlighting text or providing emphasis to text is an indication that ESL adults were familiar with the structure of text. As flight crewmembers had background knowledge of text structure on QRH checklists, it is peculiar as to why they underlined text for a different reason than how Rouhi et al. (2015) and Storch (2001) studies explained use of this metacognitive strategy. Finally, eleven percent of flight crewmembers with RCL I-level and H-level (general English language) utilized reading aloud strategy. The flight crewmembers (eleven percent) also indicated they had an RCL proficiency of H-level (crew alerting systems, QRH checklists). Flight crewmembers' indicated they read aloud QRH checklists procedures and information on crew alerting systems, as this was a common practice at their airline. They also indicated use of this strategy to ensure that understood the QRH checklist procedure. As KNKT (2015) indicated, it is a common practice to read aloud procedures to understand information on crew alerting systems and QRH checklists.

9 Conclusion

Written English language factors on each of the systems previously discussed negatively impact flight crewmember performance. Flight crewmember English language background knowledge, text genre knowledge, and vocabulary words on crew alerting systems and QRH checklists, provide an understanding flight crewmembers familiarity with their use of English language. Flight crewmember English language proficiency is a factor that can impact flight crewmember ability to read and comprehend English language. Flight crewmember English language proficiency levels are essential for understanding their metacognitive strategy use to read written English language. Strategy type and amount of strategies utilized by flight crewmembers when they read and comprehend information on alert systems/QRH checklists is important. Flight crewmember use of strategies helps to understand how they interact between information on alert systems and QRH checklists. The ICAO English language proficiency levels provided by flight crewmembers did not match their reading comprehension level of general English lexis or their reading comprehension proficiency when interacting with alerting systems and QRH checklists. The ICAO English language proficiency levels should not be the only approach to achieve English language proficiency

levels. Self-rating reading comprehension proficiency levels are an ample method of collecting data related to flight crewmembers' ability to read and comprehend English language.

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