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ROLE OF THE HUMAN ELEMENT

Human Error: Controlled Language in Operating and Maintenance Manuals Supplied to Ships

Submitted by the Institute of Marine Engineering, Science and Technology (IMarEST)

SUMMARY

Executive summary: MSC.1/Circ.1253 invited Member Governments to recognize the necessity for up-to-date, accurate and user-friendly shipboard technical operating and maintenance manuals to be available in the working language of the ship. This document provides information on the introduction of a controlled language into operating and maintenance manuals as a way of reducing human error associated with substandard content, specifically, the aviation standard of Simplified Technical English ASD-STE100 (STE). Evidence is presented to support the efficacy of error-rate reduction, and the flexibility of the standard which supports integration into other safety-critical and non-safety-critical industries. IMarEST recommends that a controlled language should be adopted as a standard for operating and maintenance manuals supplied to ships.

Strategic direction: 5.2 and 12.1

High-level action: 5.2.2

Planned output: None

Action to be taken: Paragraph 18

Related documents: MSC 83/22/4 and MSC.1/Circ.1253

Introduction

1 In 2003, the United Kingdom's Confidential Hazardous Incident Reporting Program (CHIRP), Maritime Feedback Report (MFB) No.1, called for the imposition of a set of minimum standards for operating and maintenance manuals. Since the initial report was published, standards of operating and maintenance manuals have been a consistent feature, with language and comprehension of manuals featuring in MFB Reports 4, 7 and 35.

Although these reports are based on subjective reporting, objective evidence is found in a number of casualty reports suggesting that the MFB Reports are not without foundation:

- .1 P&O SL Aquitaine – IMO No. 8908466, 27/04/00 (GISIS Ref. C0003477);
- .2 British Mallard – IMO No. 9282479, 27/01/2007 (GISIS Ref. C0006608);
- .3 Isle of Arran – IMO No. 8219554, 06/02/2010 (GISIS Ref. C0007900); and
- .4 Qian Chi – IMO No. 9262417, 16/01/2011 (GISIS Ref. C0008036).

2 In July 2006, CHIRP published a report entitled, "Marine Operating and Maintenance Manuals – Are They Good Enough?" In an attempt to establish the extent of the problem, CHIRP, in collaboration with the UK's Marine Accident Investigation Branch (MAIB), reviewed UK accident reports between 1990 and 2006, where incidents involved manuals, written procedures and/or instructions. Of 45 incidents identified:

- .1 22 manuals were not supplied or were hard to understand;
- .2 22 operating instructions were inadequate; and
- .3 One case resulted in equipment being badly maintained.

Regrettably, accidents to persons topped the list of consequences with 20 out of the 45 incidents resulting in harm. A further 14 resulted in machinery failure and the remainder in groundings, hazardous incidents, fire and explosion, capsizing and escape of harmful substances.

3 In 2007, the Australian Transport Safety Bureau (ATSB) published a report (GISIS Ref. C0006608, 2007) into the fatality of an electrical technician on board the Isle of Man registered oil tanker **British Mallard**. The incident occurred whilst the technician was working on the ship's elevator. The report cited insufficiently detailed and ambiguous safety guidance in the operating and maintenance manual as contributing factors. An extract from the operating and maintenance manual was recorded in the report, clearly demonstrating the consequences of using an uncontrolled language, as follows:

"The maintenance chapter of the instruction book contained a section titled 'Main Points of Maintenance', which included the following comments in relation to safety and electrical isolation:

- .1 'For inspection of electric part, switch off main power working;
- .2 For the disconnect switch, mark 'Do not supply';
- .3 For inspection of the moveable part, confirm no working except necessary case; and
- .4 Build up the habit to turn off the safety switch for the time of no need to move."

4 In the same year, the International Maritime Organization (IMO) issued MSC.1/Circ.1253 inviting Member Governments to recognize the necessity for up-to-date, accurate and user-friendly shipboard technical operating and maintenance manuals to be available on board ships. In doing so, IMO endorsed the International Association of Classification Societies (IACS) Recommendation No.71 (2000) as guidance for preparing

shipboard technical operating and maintenance manuals and recommended that operating and maintenance manuals should be translated into the working language of the ship (or into English, French or Spanish, if the working language differs). However, the circular and recommendation stopped short of proposing a controlled language as a way of achieving these goals. Despite these publications, CHIRP continued to receive reports describing difficult, ambiguous and poorly translated operating and maintenance manuals (CHIRP 35, 2014).

5 This document introduces the standard of Simplified Technical English (STE) developed in the aviation industry to minimize human error in maintenance tasks. Its application, control and effect are discussed and reference is made to a number of peer-reviewed studies where appropriate.

Controlled Language: What is it and what does it do?

6 In the last century, English became the international language most used by communities, organizations and industries for promoting their businesses and documentation. However, it is not always the native language of the readers and the authors of such documentation. People with a limited knowledge of English are easily confused by complex sentence structures and by the several meanings and synonyms that English words can have.

7 In the early part of the 20th century, Professor Charles K. Ogden created Basic English (1930), which consisted of a set of simple grammar rules and a restricted vocabulary of 850 words. It was the first real attempt to "give everyone a second or international language" for business and education in every country, with the primary aim of promoting communication between people, a means for world peace, and an aid for translation. We can consider Basic English as a pioneer controlled language. From there, other controlled languages were developed, each of them dedicated to different fields of application. In the 1970s, Caterpillar created "Caterpillar Fundamental English" (1973), to make operating and maintenance instructions easily understood by their customers and users. In the 1990s, the President of the United States introduced the use of Plain Language in all government regulations; the United Kingdom Government and other English-speaking countries used the same approach. The new South African Constitution of 1996 is perhaps the first in the world written in scrupulous respect of the principles of Plain Language.

Origins of Simplified Technical English

8 In 1979, the Association of European Airlines (AEA) thought that a simplified language applicable to the aircraft maintenance documentation was necessary. The European Association of Aerospace Industries (AECMA) agreed to find a solution and started the project with the Simplified English Working Group (SEWG). After the initial analysis of many maintenance texts, the SEWG defined a set of writing rules, a controlled dictionary, and examples. The Aerospace Industries Association (AIA) of America also sent their representative to the working group. Simplified Technical English (STE) was the first specification released as the AECMA Simplified English Guide in 1986. In 1987, the major specification for writing maintenance manuals, ATA 100 (now ATA iSpec 2200) and, in 1989, the new AECMA 1000D (now S1000D), made STE a mandatory requirement. In 2005, AECMA became ASD, "The AeroSpace and Defence Industries Association of Europe" and the AECMA Simplified English Guide became an official Specification, ASD-STE100, with the word "technical" added to its name.

Modern Controlled Language in the Aviation Industry: ASD-STE100

9 The STE specification provides a set of writing rules and a dictionary of controlled vocabulary. The writing rules (approximately 60) cover aspects of grammar and style; the dictionary (approximately 860 words) specifies the general words that can be used. These words were chosen for their simplicity and ease of recognition. In general, there is only one word for one meaning, and one part of speech for one word. Besides the specified general vocabulary, STE accepts the use of company-specific or project-oriented technical words (referred to in STE as Technical Names and Technical Verbs), if they fit into one of their categories listed in the specification.

10 Controlled grammatical structures and vocabulary, on which STE is based, have the purpose of producing texts that are easily understandable and consequently STE can reduce human errors during the maintenance tasks. As technology in aviation becomes more reliable, human errors become the primary cause of safety events. In aviation, the concept of Human Factors is directly connected to maintenance. During maintenance, a person can do an incorrect task which can cause a malfunction of components and systems. This malfunction can have important effects on flight safety. The language used in the procedures is important for the correct maintenance. It is more important when the operators use texts not written in their native language and they do not have a good knowledge of English. The operators must understand all procedures and they must do the tasks correctly. A simple and correct text can reduce maintenance errors and so limit the risks related to human factors.

Control and Development of ASD-STE100: Role and make-up of STEMG

11 The STE specification, trademarked by the European Community in 2006, is currently maintained by a dedicated group, the ASD Simplified Technical English Maintenance Group (STEMG), which consists of members from the ASD member countries, Argentina, Canada, the Russian Federation and the United States of America. In addition, associate members represent the customers (airlines and military organizations), including one associate member from the New Zealand Navy.

12 The current issue of STE is dated 15 January 2013 (normally, one issue every three years). Although the STE structure is stable and consolidated, the language has to be kept in line with the technology evolution and amended on the basis of the continuous and important feedback received from the users.

Studies: Overview of scientific studies into error reduction

13 Drury and Ma (2003) discussed the difficulty of moving between languages for non-native English speakers and the additional potential for error. Non-native English speakers are said to be exposed to a "translation burden," which potentially increases workload, performance time and/or error rate. In studying airlines with a low level of English-speaking ability, Drury and Ma found that 100% of the airlines studied conducted on-site maintenance training in a language other than English (i.e. in the native language). Approximately 85% of the airlines held meetings in a language other than English, whilst in contrast 85% of the airlines retained maintenance manuals in an original English-language format only.

14 Due to its commercial origins, a number of studies were completed over the years to determine the impact of STE on maintenance tasks. Shubert et al. (1995), in collaboration with The Boeing Company, studied the effects of STE with 127 participants. Their study found that STE supported information location and reduced comprehension errors in procedure-based maintenance tasks. The benefits of STE became more significant with the use of complex procedures and where the participant was a non-native English speaker. Chervak and Drury (2002/2003) studied experienced and inexperienced participants

performing easy and difficult tasks on an internal combustion engine using original, STE and hybrid procedures. Their study suggests that task errors were reduced with STE and increased with hybrid procedures. Chervak et al. (1996) expanded on Chervak and Drury's work by applying a similar method of study to 125 aircraft maintenance technicians (AMTs). The AMTs were given comprehension tests on a series of STE and non-STE procedures. The STE versions were found to reduce comprehension error rates with the most significant error reduction being with regard to complex procedures and non-native English-speaking participants.

Current Application to Other Industries

15 Today, the success of STE is such that other industries use it beyond its intended purpose of aviation maintenance documentation. The interest in STE is also growing within the academic world, and for its principles and accuracy it is a model writing standard for other domains and industries, such as information technology, medical, oil, high-tech, transport and many others. A 2008 study of STE shows that only 2% of the current content is specific to aviation; the remaining 98% is applicable in all contexts, without any need for adaptation (Chiarello, 2008).

Summary and recommendations

16 Evidence obtained from objective and subjective reporting suggests that the standards of operating and maintenance manuals promote or mitigate human error in procedure-based tasks. A controlled language, Simplified Technical English ASD-STE100, used within the aviation industry, has proven to have useful characteristics for the reduction of human error. Furthermore, the integration of the specification into non-aviation industrial settings demonstrates the flexibility of Simplified Technical English towards its suitability to the maritime industry. Where English is the official working language, this paper recommends the use of a controlled language in standardizing content and structure of operating and maintenance manuals supplied to ships.

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- .10 Confidential Hazardous Incident Reporting Programme (CHIRP), (2014). *Maritime Feedback* 35, pp.2-4.
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- .15 Marine Accident Investigation Branch (MAIB), (2001). Report on the investigation of the impact with the quay by passenger ro-ro ferry P&OSL Aquitaine at Calais on 27 April 2000. Report 27/2001. Southampton.
- .16 Ogden, C. (1930). *Basic English*. 1st ed. London: K. Paul, Trench, Trubner & Co.
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- .18 Verbeke, C. (1973). *Caterpillar Fundamental English*. *Training and Development Journal*, 27(2), pp.36-40.

Action requested of the Sub-Committee

- 18 The Sub-Committee is invited to note the information provided.