

## FEATURE ARTICLE

### Read it and heed it — readability of safety documents

G Taylor

Geoff Taylor, MSc, GradDipBusAdmin, is an Adjunct Professor in the Department of Civil Engineering at Curtin University, Australia. He is a director of Work Safety and Health Associates and Enhancing Safety Pty Ltd, and a Chartered Fellow of the Safety Institute of Australia. As a writer of WHS textbooks, and editor of the *MARCSTA Monitor*, a mining safety newsletter, he has a strong interest in readability.

Address for correspondence: Geoff Taylor, Work Safety and Health Associates, 18 Parklands Sq, Riverton, Western Australia, 6148, Australia.

#### Abstract

This paper describes measurement of the readability of a range of Australian Governments' work health and safety (WHS) documents covering a range of WHS topics and comparing these with what is known of adult literacy levels in Australia.

Readability was measured using an algorithm developed by McLaughlin.<sup>1</sup> The results on the limited sample indicate that a significant part of the working population would have difficulty using these documents, without assistance.

**Keywords:** safety and health documents, readability, literacy levels.

#### Introduction

Australian Government work health and safety (WHS) documents (hard copy and online) include national, state and territory legislation, codes of practice, guidance notes and guidelines, various warning bulletins and newsletters, and national standards (these are different from Australian standards). Regulations and codes of practice often include Australian and international standards by reference. However this study deals with codes of practice and guidance notes issued by government WHS authorities.

Key WHS documents include those on plant because 42.8% of work-related deaths and 44.2% of work-related injury and disease originate from plant, including equipment, tools and scaffolding.<sup>2,3</sup>

Safety data sheets (SDS) should also be readily understandable. Workers Compensation Fund, Utah, US<sup>4</sup> records an analysis done for OSHA by the University of California at Berkeley, US on literacy and safety training which found that the average material safety data sheet (MSDS, now SDS) is written at a college (university) level. This is well above the comprehension level of most workers.

Another crucial area is WHS procedures. Although well-trained people are sometimes critical of over-reliance on these,<sup>5</sup> they play a crucial role in the interaction between the worker and plant. Many procedures stem from approved codes of practice and guidance notes, and from Australian standards.

Writing easy-to-understand procedures has been addressed by Workcover NSW.<sup>6</sup>

For government WHS documents to be fully effective, and, importantly, to assist in compliance with WHS law, the literacy levels which WHS documents demand must be matched by the literacy levels of the users in the Australian population.

In the light of the recent Montara offshore oil spill and fire, and the onshore Varanus Island gas plant fire in 2008, it is of note that petroleum industry health and safety representatives' training includes the safety case. This is the more complex end of safety documentation and one adopted as a requirement, for example, by NOPSA. It sets out the adequacy of a worksite's safety management system, by outlining prevention and control measures and strategies for preventing a major incident, and for reducing the impact if one occurs.

One of the more difficult parts of developing a safety case is weaving the various threads of supporting evidence to construct a coherent argument on how these threads contribute to the overall safety level of the facility.<sup>7</sup>

To assess literacy issues, the International Adult Literacy Scale (IALS) has been developed. In this "the abilities of individual survey takers are described in terms of the ability to complete literacy tasks at a known level of difficulty on the scale".<sup>8</sup>

Documents containing arguments are rated as a Level 6 literacy task in the IALS scheme, which is the most demanding level. In Australia health and safety representatives in the oil and gas industry are trained to interact with the safety case under the NOGSAC<sup>9</sup> competency requirements, although this may not necessarily involve being able to understand the arguments.

So documentation is a crucial part of WHS management. Taylor<sup>10</sup> details a range of health and safety documentation which may be required as part of a WHS management plan. Government WHS documentation is often necessarily interpreted and adapted for use in organisational WHS material. Such documents must be understood and must be able to be applied by those using them.

#### *Document structure*

It is a matter of common experience that degree of difficulty in reading and understanding text relates to the font, word choice, word order, grammar, sentence structure and layout of text, and whether it includes graphics or tables. Tests have been devised to assess the readability of texts, in both prose documents, for example, the Fry Readability Graph, the Flesch-Kincaid Formula,<sup>11</sup> the SMOG Formula and in prose/graphic documents.<sup>8</sup> The Flesch-Kincaid formula is used by Microsoft Word® to compute readability. The tests give a readability score either equivalent to, or in terms of, US school grade levels.

Doak and Doak, pioneers of health literacy,<sup>11</sup> recognised that organisation, layout and design contribute to overall comprehension and they developed the Suitability Assessment of Materials (SAM). SAM assesses in six areas. Mosenthal and Kirsch<sup>8,12</sup> developed a new measure for assessing document complexity.

The reader of a document hunts for the keys to understanding it. A tabular layout can assist this process, where appropriate, as can consistent structures in a series of documents.<sup>13</sup>

There is often a disconnect between how the information designer frames information and how the information consumer perceives it. Many public documents exhibit this defect.<sup>8</sup> Evetts' paper<sup>8</sup> is a training document intended for information designers, so that they can try to match the complexity level of public documents with the ability level of the target user group.

Evetts describes factors other than readability which are taken into account in assessing the cognitive tasks involved in document complexity analysis. Interestingly, his paper goes on to give a worked exercise relevant to WHS, relating to gas respirators. He notes that the skills acquired transfer to other contexts.

### *Readability*

Reading is much more than decoding written words and literally comprehending them. It includes understanding texts at a general level, interpreting them, reflecting on their content and form in relation to the reader's own knowledge of the world (so context is important) and arguing a point of view in relation to what has been read, according to the Programme for International Student Assessment (PISA).<sup>14</sup>

Reading-to-do is distinguishable from reading-to-learn, and readability of documents forms only a part, although a key part, of the literacy demands of documents. So, these literacy demands are a somewhat broader concept than readability, and have been the focus of considerable work both in Australia and internationally.<sup>14,15,16,17</sup>

Reading-to-do imposes thought processes which can be described and rated for complexity.<sup>8</sup>

No research on the readability or literacy demands of Australian WHS documents could be found. Yet the provision of information is an important obligation under duty of care in all Australian WHS legislation. The levels of literacy demanded by the documents versus those found in the Australian population must therefore be of concern.

### *Measuring techniques*

Tools are available to measure readability and literacy demands of documentation and to measure the literacy levels of workers.

Reading grade level (RGL) is the usual gauge of readability.<sup>8</sup> However RGL and the use of readability formulas does not capture the information about organisation of the text passages. RGL does not describe document complexity well where the text is not continuous or where much of the meaning is in graphics. The use of bullet points, for example, may make material more readable.

McLaughlin<sup>1</sup> found that sentence length, sentence structure and the number of syllables in the words were important factors in readability. Renaissance Learning<sup>18</sup> found a high correlation between sentence length and comprehension by students at successive years of education, although sentence structure also plays a part.

The longer a sentence, the greater the demands on focal working memory while its meaning is being assessed.

### *Literacy*

Levels of literacy as they apply to various job roles and their associated documentation such as procedures and standards, are clearly crucially important.

Kirsch,<sup>15</sup> discussing the IALS, gives examples of prose tasks with six different difficulty values. These are set in six adult contents/contexts. Among the six contents/contexts for adults was health and safety, including materials dealing with drugs and alcohol, disease prevention and treatment, safety and accident prevention, first aid, emergencies and staying healthy.

A reader's proficiency score is determined such that the reader has an 80% chance of success in reading at that level. For instance, a reader with a score of 350 will have an 80% chance of success at Level 4. The top is Level 5. A score of 350 means 100% success by that reader for a Level 1 prose task and 68% success at Level 5. The comparative figures for document tasks (ie partly graphic documentation) are 100% and 41% respectively. However a reader proficiency score of 150 means 48% success for a prose document at Level 1 and 2% for Level 5, and 40% and less than 1% respectively for a partly graphic document.

Kirsch details the types of documents people may need to understand.<sup>15</sup> For instance a safety case as in Kelly<sup>7</sup> would be a continuous text of the argumentation type. "Level 3 proficiency in each of the domains is considered to be the minimum required for coping with the work and demands of life in 'knowledge' or 'information' societies".<sup>15</sup> ABS<sup>16</sup> in the 1996 Survey of Aspects of Literacy (SAL, part of the IALS) describe criteria for the levels. ALLS has five levels (except for problem solving).

Documentation can become more accessible through hypertext, but some research suggests that the reader can easily become lost in the levels, and the links encountered.<sup>19</sup> There are ways of overcoming this.<sup>20,21,22</sup> Problems can also arise with complex forms, such as those relating to the Esso Longford fire.<sup>23</sup>

### *Literacy in Australia*

Adult literacy levels were accurately measured in Australia in 1996 in the IALS study<sup>8,16,24</sup> and then in the international ALLS study covering ages 15–74.<sup>17</sup>

A consideration of how well Australians are equipped, from a literacy standpoint, to effectively use WHS documentation is therefore vital. The ALLS provides a basis to do that.

Hagston<sup>24</sup> examined the implications of the IALS survey data for Australia. The four greatest influences on literacy proficiency in Australia are native versus foreign language, educational attainment, occupational category and age in that order.

Shore<sup>25</sup> notes that it is possible that 18% of the population performing at Levels 1 and 2 are working in the manufacturing or retail industries, if the 1996 IALS survey reflects South Australian proficiency.

ABS<sup>17</sup> notes that the ALLS provides information on knowledge and skills in the following four domains; prose literacy, document literacy, numeracy, problem solving, and a fifth domain, measuring health literacy. "Health literacy is defined as the knowledge and skills required to understand and use information relating to health issues such as drugs and alcohol, disease prevention and treatment, safety and accident prevention, first aid, emergencies, and staying healthy ... Level 3 is regarded by the survey developers as the minimum required for individuals to meet the complex demands of everyday life and work in the emerging knowledge-based economy."<sup>17</sup>

The US National Institutes of Health and Agency for Healthcare Research and Quality<sup>26</sup> note that limited numeracy can also impede the ability to make personal decisions related to risk, risk avoidance and risk reduction, all important in WHS.

Here is what the ALLS study showed about the prose, document and health scales. "Approximately 7 million (46%) Australians aged 15 to 74 years had scores at Level 1 or 2 on the prose scale, a further 5.6 million (37%) at Level 3 and 2.5 million (16%) at Level 4/5. Results for partly graphic document literacy were similar to those for prose. On the health scale, approximately 9 million (60%) Australians attained scores at Level 1 or 2, a further 5.2 million (35%) were at Level 3 and 900,000 (6%) were at Level 4/5." So 83% of Australians could have trouble with prose or documents above Level 3.

At this point it is pertinent to note that selection mechanisms for employment increase the percentage of people literate to a certain level in particular workplaces and occupations, as compared with population means. However on the figures above, c. 46% of people will have trouble with material of Levels 3–5, and even more for material covering health issues.

Graduating from initial formal education with literacy skills at a certain level does not guarantee lifetime skill retention at that level. Forces such as TV soundbites, mobile phone and email shorthand may also degrade literacy. Shore<sup>25</sup> observes that literacy skills can atrophy, if not used, maintained and developed.

Shore<sup>25</sup> also notes that:

- over 6 million Australian adults can be expected to experience difficulties in using printed materials.
- only 2.3 million adults [out of a workforce of 10 million] have the capacity to respond to higher order literacy skills
- the largest category of respondents in each of the three domains is in level 3 and each is around 35-36% of the population sample."

PISA<sup>14</sup> tested Australian secondary students for skills, including literacy skills, anticipated in the 21<sup>st</sup> century. That is the ability to understand, use and reflect on

written texts in order to achieve one's goals, to develop one's knowledge and potential, and to participate effectively in society.<sup>14</sup>

PISA uses a different literacy scale from that of the IALS, and somewhat different dimensions of literacy.

PISA found that 31% of students could not satisfactorily handle material above Level 2, in regard to retrieval, interpretation and use.

#### *Linking readability and population literacy*

Considering readability of documents per se, Table 1 shows the SMOG grade, which is the reading grade that a person must have reached if they are to fully understand the text assessed. The standard error is 1.5 grades.

**Table 1: SMOG grades and educational levels<sup>1</sup>**

SMOG grade	Educational level	Some examples
0-6	Low-literate	
7	Junior High School	
8	"	
9	Some High School	Readers Digest
10	"	
11	"	
12	High school graduate	Time Magazine
13-15	Some college	New York Times
16	University degree	
17-18	Postgraduate studies	Harvard Business Review
19+	Postgraduate degree	Tax law (US)

It is important to bear in mind that the table refers to US educational levels, and that the educational criteria set in those levels may have changed over some 40 years. The literacy demands of the examples cited may also have varied. However they provide a useful indication.

SMOG grades 10-11 may be compared with the mid-high school population used in the PISA<sup>14</sup> study.

In 2000, c. 42% of the Australian students in the PISA study met the retrieval, interpretation and reflection, and evaluation requirements at Level 4 or above. So c. 58% of Australian mid-high school students might be expected to have difficulty with material of SMOG grade 11 or more.

So, are the readability scores of government documents appropriate, given what is known about the reading grade levels of the user population?

This paper examines, using a preliminary survey, how well a selection of government WHS documents (excluding Acts and Regulations) meet readability requirements for the Australian workforce.

Readability grades of selected operative parts of a range of Australian Governments' WHS documents are presented here, using the McLaughlin SMOG approach. Rudd<sup>11</sup>

notes: "The Health Literacy Studies Group [at Harvard University School of Public Health] often uses the SMOG in its research, and finds the formula easy to compute and well designed for field work".

### Method

The method used involved carrying out McLaughlin readability assessments on selected operative parts of 20 current government documents providing guidance on aspects of WHS. In each case, the electronic version of the document as it existed online in January 2010 was used.

The software for the SMOG algorithm developed by Trottier<sup>1</sup> allows rapid assessment of a piece of text ranging from 30–2,000 words, however, the values in Table 2 below were calculated from manual scoring of the documents, and then the SMOG value calculated using the algorithm developed by McLaughlin (not the method suggested by him for a rapid approximate value). This approach allowed assumptions to be made about certain aspects of the documents and these are noted where appropriate.

The recommended number of sentences to be sampled for SMOG is 30, so that words per sentence can be eliminated as a parameter, but this was constrained by the varying nature of the materials. So the words per sentence column highlights this aspect. For example, as a datum point, the following sentence with a subordinate clause, contains 18 words: "An SDS, or safety data sheet, is a very useful tool for giving you safety information on chemicals".

The documents assessed were chosen from all states and territories and the Commonwealth, and covered a broad range of WHS topics.

### Results

The results are set out in Table 2.

**Table 2: Readability grades of selected operative parts of WHS documents**

Source	SMOG grade	Words	Polysyllabic words	Polysyllabic %	Words/sentence
1. WA Dept Mines and Petroleum Contam System Procedures 2008	11	566	103	18.2	10.9
2. SWA National Standard for Plant — duties of self-employed 1994	14	310	43	13.8	23.8
3. NT WHA Fatigue CoP — Guiding principles 1998	13	353	61	17.2	16.0

<i>Source</i>	<i>SMOG grade</i>	<i>Words</i>	<i>Polysyllabic words</i>	<i>Polysyllabic %</i>	<i>Words/sentence</i>
4. NSW H&S Guidelines for Brothels — H&S of others 2001	15	537	107	19.9	20.6
5. SWA GN Occupational Exposure Limits — excursion limits 1995	18	647	153	23.6	28.1
6. ACT Steel Construction CoP — erector role 1997	16	411	85	20.7	24.2
7. NSW Electrical on Construction Sites CoP — cord installation 2007	14	338	59	17.4	19.9
8. Qld Mobile Crane CoP — load charts 2006	12	503	57	11.3	22.9
9. NSW Chemicals in Agriculture CoP — labels, MSDS 2006	16	540	129	23.8	16.4
10. Qld Tunnelling CoP — diesel emissions 2007	15	320	62	19.4	22.8
11. Qld Concrete Pumping CoP — planning by the pumper 2005	14	419	74	17.7	19.0
12. SA First Aid CoP — first aid services 1991	13	303	49	16.7	18.9
13. SA Labelling CoP — description of label items 1995	15	893	198	22.1	18.6
14. ACT Cash Transport etc CoP — SoPs 2003	17	423	112	26.4	21.2
15. Vic Falls in Housing Construction CoP* — installing pre-fab roof trusses 2004	12	398	50	12.5	19.0



Source	SMOG grade	Words	Polysyllabic words	Polysyllabic %	Words/sentence
16. NSW Workcover Management Handling Risk Guide – elimination or control management in handling risks. c. 2008	12	394	62	15.7	16.4
17. WA Worksafe Noise CofP – engaging treatment of source 2003	14	632	115	18.2	18.1
18. NSW DPI Mine Safety Management Plan GN – contractor management plan 2009	15	176	44	25.0	17.6
19. NSW Construction Work at Coal Workplaces GN – design of structures, buildings, shafts 2008	15	423	59	13.9	32.5
20. Tas Agricultural Shows CofP – organiser duty of care c.2005	15	685	114	16.6	27.4
Mean	14			18.2	20.7

CofP = Code of Practice, GN = Guidance Note, polysyllabic = three syllables or more.

\*Note: Victoria no longer produces codes of practice as its legislation now omits them

In items 1, 7, 9, 11, 12, 13, 15 and 17, bullet points, a series of points labelled with lower case letters, or a series with small Roman numerals, were treated as separate sentences. The introductory phrase (ending with a colon) which precedes the phrases marked with a bullet, numeral or letter is usually of the do or don't do form. So it was assumed that this is easily held in focal working memory, while the "run-on" bullet points are being read. Headings were also treated as a sentence.

Certain abbreviations were scored as commonly pronounced. For example, ADG, f/mL, TWA, mg/m<sup>3</sup> were treated as polysyllabic words, but "STEL" and numbering such as "6.6" weren't.

### Discussion

The most demanding material is that selected from the Safe Work Australia Guidance Note on OELs (result 5 with a SMOG grade of 18). However the material which places the least demand on the reader is that selected from the Western Australian DMP Contam System Procedures (result 1, SMOG grade 11). This corresponds to upper "some high school" in Table 1. In view of the comments about the plant standard in the Introduction, it is of note that item 8, which is plant-related, had a good readability score.

As noted earlier in Lokan et al.,<sup>14</sup> a score of 11 suggests that 57–58% of mid-high school students would not be able to fully understand the materials. The mean SMOG grade of the materials was 14, well above 11, requiring some college (university) education.

While a direct comparison with the figures given by Shore<sup>25</sup> and ABS<sup>16</sup> can't be made, 83% of Australians were found in the ABS study (people aged 15–74) to have difficulty with anything above the ALLS Level 3. However those who took part in the PISA study 11 or so years ago at age 15 are now in the workforce at around age 26, and for that group, provided the skills have not been degraded or augmented in the interim, the figure is 57–58%.

Two layouts deserve mention for decreasing readability. The first (item 11) involved one opening phrase with a colon, leading to two further phrases with a colon and introduced with a capital letter, each of which in turn was the opening phrase for more points of information. The second (item 15) involved adding two phrases introduced by dashes in a bullet point which followed on from the opening phrase, and then continuing to the next bullet point, which required referring again to the opening phrase. See Table 3.

**Table 3: Illustration of difficult to follow prose layouts (each letter represents a phrase)**

Item 11	Item 12
A:	A
B:	● B
c	-c
d	-d
e	● E
F:	-f
g	-g
h	
i	

In the case of item 20, 23 of the sentences were written succinctly (mean 23.4 words per sentence), but these were followed by two "mouthfuls" (mean 73.5 words per sentence).

### Conclusion

There are some limitations in this research. However the results do suggest that more attention could be paid to the readability of WHS documents, and not just those of governments. Many intended users would have difficulty reading those documents with higher readability scores produced by government WHS bodies.

An initial approach might be to run the document through the Microsoft® Flesch-Kincaid readability test, although it is not known how well this handles material other than straight prose (to use this, in Word®, click Tools, Spelling and Grammar,

Options, Enable Readability Statistics, OK, Close, then click ABC on the toolbar). In this context, note that the software developed by Trottier<sup>1</sup> to calculate SMOG gives quite different results from a manual calculation, because when it is not straight prose, assumptions must be made.

More comprehensive research is necessary to assess literacy demands of Australian WHS documentation, using techniques such as those given in Evetts<sup>8</sup> and Mosenthal and Kirsch,<sup>12</sup> and to develop approaches which better match literacy demand to workers' literacy levels.

It would be useful to examine the possibility of changing a range of longer words common to WHS to shorter ones. The choice of the word "work" over "occupational" in the current national uniformity agenda is an example.

Interactive devices such as Kindle® and iPad® will find increasing use in bringing documents into the workplace. Many of the documents examined here lend themselves to having a corresponding checklist, and so an "App" which does this will be useful.

Fresh approaches may be of use, for example, Reinert et al<sup>27</sup> evaluated another idea for assessing the effectiveness of machinery documentation. It presented several techniques for the production of simple explanatory material for complex devices.

This paper hasn't addressed the issue of people at work in Australia who don't generally rely on English for communication, or the literacy issues of those with English as a second language, although it is acknowledged that this is a key issue, with high migration rates and employment of 457 (temporary work) visa workers.

That issue therefore deserves further attention, because even if WHS documents are produced in languages other than English by government WHS authorities or organisations, levels of literacy in the first language vary, as does understanding of concepts like risk. Note, for example, Workcover NSW, Essex, OSHA and Florida Department of Education.<sup>28,29,30,31</sup>

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