
SITUATIONAL SAFETY AWARENESS IN THE AVIATION ENVIRONMENT

ASSESSING NON-TECHNICAL SAFETY SKILLS
USING THE SSA INVENTORY



PROGRESSIVE
AVIATION
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THE SITUATIONAL SAFETY AWARENESS TEST

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Delivered in an economical and convenient online format the Situational Safety Awareness Test (SSA) provides an effective tool to measure responsiveness, vigilance and attention in both cognitive and behavior dimensions of personnel.

Successfully used in other industries the SSA is now available for the delivery of critical safety information in a format contextualized for aviation operations.

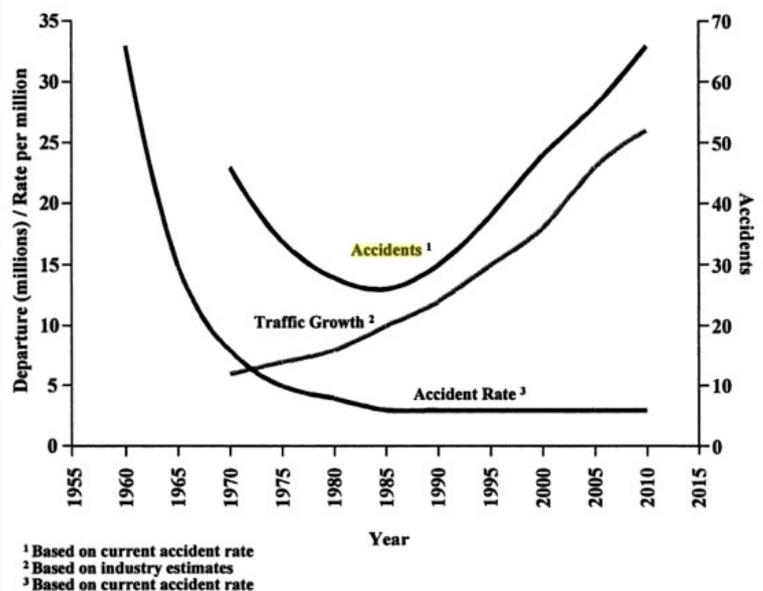
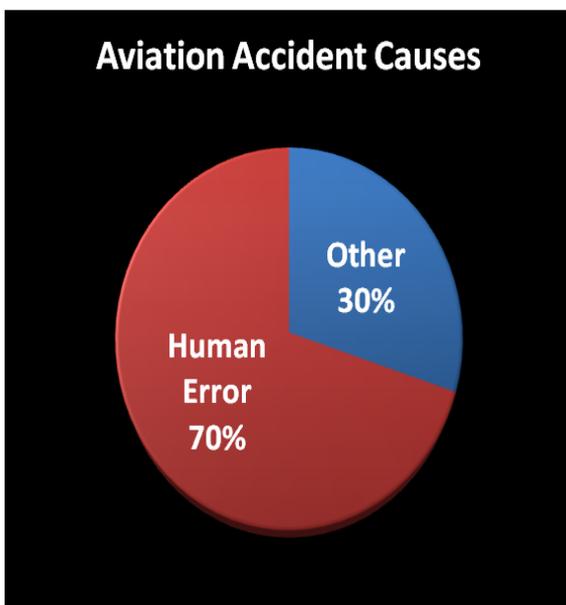
The test consists of a standardized safety specific behavior and competency based questionnaire founded on the most current research concerning why incidents occur in safety critical industries.

MANAGING THE HUMAN FACTOR WITH COGNITIVE SAFETY APTITUDE ASSESSMENT

The high-risk nature of aviation operations has led to a naturally regulated environment. However, accident and incidents continue to occur due to the variability of human behavior within complex aviation systems.

This human variability has led to a plateau in accident rates in recent years which must be addressed through improved human error detection and prevention strategies; if accident levels are to remain acceptable with increasing worldwide fleet utilization.

Within the modern aviation environment, 70% of all accidents can be attributed to human error in some form. Of these, loss of situational awareness has been cited as a contributing factor in up to 85% of accident reports¹.

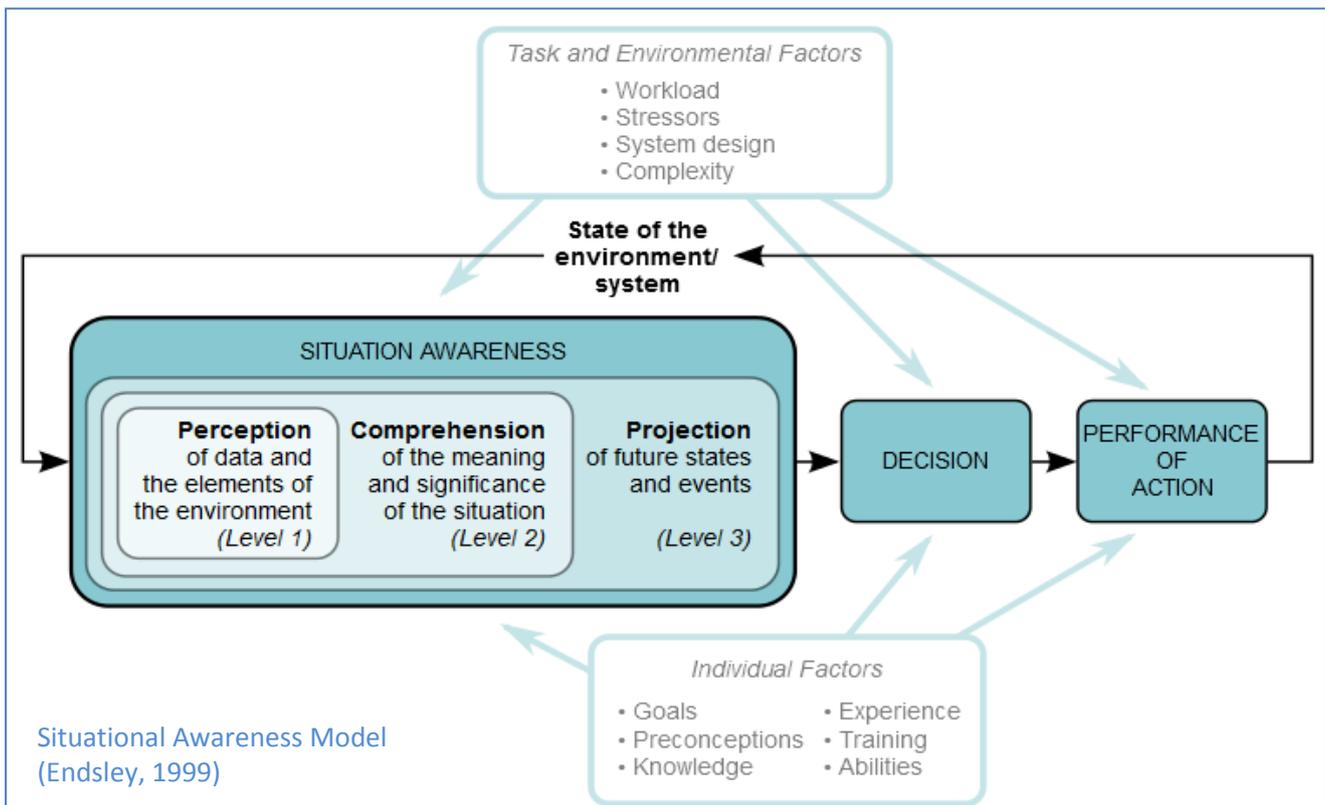


¹ Airbus. (2007) Flight operations Briefing Notes; Human Performance; Enhancing Situational Awareness. Blagnac, France: Airbus Customer Services.

Situational awareness consists of three key cognitive elements; detection of elements in the current state (perception), understanding what those elements mean (comprehension) and prediction of future status (projections).

Most notably, situational awareness has been identified as a key element to success in a wide variety of aviation operations including maintenance, piloting and air traffic control. Previously, loss of situational awareness has been cited as a factor in performance failures of both aircraft maintenance engineers and pilots.^{2,3}

The model of situational awareness⁴ demonstrates how a breakdown of any element creates a bottleneck; inhibiting both decision making and action selection, and ultimately leading to greater potential for unsafe acts.



Several studies of incidents across aviation industries^{2,5,6} have identified cognitive failure as the precursor to loss of sensory and mental perception and ultimately, loss of situational awareness.

Developed after comprehensive testing for the munitions industry, the SSA can be used to effectively assess an individual's inherent ability to maintain vigilance, identify risks and to assess and respond to physical and mental stressors (i.e. fatigue, distraction etc.). In short, his or her tendency towards maintaining situational awareness.

² Endsley, M.R & Robertson M.M (1998), Situational Awareness in Aircraft Maintenance Teams. International Journal of Industrial Ergonomics. (26), p.301-325.

³ Shook, W.C. Bandiero, M. Poello, J.P. Garland, D.J & Endsley, M.R. (2000), Situational Awareness Problems in General Aviation. Proceedings of the Human Factors and Ergonomics Society Annual Meeting, 2000 (1) p.185-188

⁴ Endsley, M.R (1999), Situation Awareness in Aviation Systems. In D.J Garland, J.A Wise & V.D Hopkin, (Eds). Handbook of Aviation Human Factors. Mahwah, N.J.: Erlbaum.

⁵ O'Hare, D. (2006). „Cognitive Functions and Performance Shaping Factors in Aviation Accidents and Incidents. International Journal of Aviation Psychology; 16 (2), p.145-156

⁶ Jones, D.G & Endsley, M.R. (1996). Sources of Situational Awareness Errors in Aviation. Aviation, Space and Environmental Medicine. 67(6), p.507-512

ADVANTAGES OF ASSESSING NON-TECHNICAL SKILLS WITH THE SSA

Compared with conventional measures of safety attitude, the SSA offers significant advantages in the assessment of individual non-technical skills. This is primarily due to its capability to identify individuals who are prone to breakdown in safety despite having a strong safety attitude, and those who are able to maintain the “presence of mind” required to respond in an appropriate manner under a variety of stressors. Additionally the SSA provides the following significant advantages to recruiters:

Initial detection capability: The SSA provides unrivaled capability in detecting employees who may respond well during initial safety attitude tests or interviews, but who remain prone to breakdowns in situational awareness and subsequent loss of safety.

Empirical reliability: The SSA has been empirically validated indicating that those with a score below that of an average worker can be observed to display more unsafe behaviors and a tendency to loss of situational awareness.

Improved selection certainty: Uncertainty is removed from the employee selection process due to the SSA’s empirical reliability and focus on detecting key indicators of vulnerability to loss of situational awareness.

Expedient selection capability: The SSA’s efficient and convenient online format allows selectors to critically assess individual safety awareness in contexts where tight labor markets and immediate staffing demands may result in an expedited screening process and subsequent less than optimal labor base.

Discretionary selection: Selectors are free to select a suitable cutting score for potential candidates based on organizational requirements. Commonly this cutting score is based on the average person’s ability to avoid injury while at work when unencumbered by other factors (i.e.: environment, illness, preoccupation etc.)

Ongoing workforce analysis capability: The SSA inventory’s simplicity and ease of distribution makes it the ideal assessment tool for assessing non-technical skills during and after major changes in organizational structure (i.e. merger or acquisition of new employee base) or as an assessment tool for non- technical skills training programs.

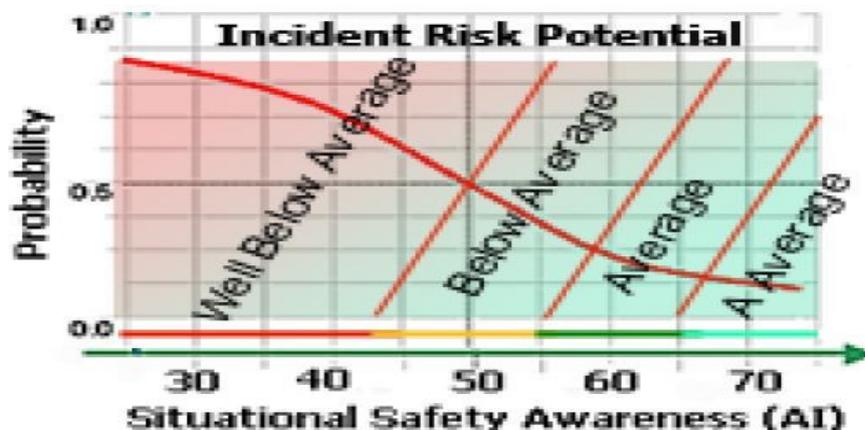
TEST PERFORMANCE RESULTS

The high validity and targeted occupational safety relevance of the SSA has led to its wide use across a diverse range of sectors including mining, medical and general industrial occupations. The high validity of the SSA is confirmed by a predictive validation sample of **808 mining and heavy industry employees and new recruits** carried out in Western Australia. Within this study:

- New recruits tested with the SSA and scoring 60 or greater were seven times less likely to have incidents than untested recruits.
- Less than 1.5% of tested recruits accounted for 9.25% of incidents whereas 10.3% of untested employees accounted for 90.7% of incidents. This indicated a better than 1:6 incident participation ratio in favor of tested recruits.

PREDICTIVE CUTTING SCORE

Known as the “Adjusted Assessment Index” (AAI) the cutting score lies on the probability curve indicating the candidate’s degree of vulnerability to loss of SSA compared to normal (very low incident likelihood) workers.



To take into account the combined behavioral and ability measures included in the SSA, the AAI has been set as a weighted normative score; allowing comparison of individuals against the performance of those with low risk of SSA loss.

The SSA cutting score has been further balanced by taking into account average completion time, and the weighted contributions of the included competencies to prevent distortion of the results.

Individual scales within the test are referenced (against a 2009 sample of 12,000 respondents from various industries) in such a way that proficiency is demonstrated by achievement of a benchmark based on the division between normal personnel and those who are prone to breakdown in the subject area.

AAI SCORES AND CANDIDATE ASSESSMENT

A cut-off score for the acceptance of applicants can be customized to suit the recruiter, and is frequently set at the mean of a safe (low incident rate) population. This is often around 60, where 55 represents low average performance and 65 high average performance.

In addition to the AAI score, assessors are provided with detailed client reports to aid in equitable and knowledgeable discretionary decision making. The option to set a decision score based on the lowest bounds of acceptability remains with the recruiter.

When assessing individual scales, the candidate’s immediacy to the criteria is of greater importance than the specific score achieved. In each of the scale measures, standard deviation from the mean is used to make allowances for normal individual differences; and the midpoint of the standard deviation contributes to the candidate’s final AAI score.

The normal range for AAI scores is 55-65 with increasing likelihood of unsafe behavior as scores decrease below 55 and decreasing risk as the AAI score increases above 55.

SSA SCORE DEFINITIONS

Eleven key scales form the basis of the SSA and allow for a more detailed assessment of a candidate's individual characteristics. The key scales are:

Risk Avoidance

Assesses candidate's tendency to seek or avoid risky situations such as workarounds, rule violations, or complex tasks involving considerable skill level or a lack of control. High scoring candidates in this scale would be considered to display a strong ethical tendency toward rules and procedures.

Understands Fatigue

Assesses the candidate's attentiveness to hazards related to sleep deficiency, sleep debt and generalized fatigue as well as understanding of sleep effects on performance. Also assesses candidate's understanding of the effects of stimulants, age and various other conditions on performance ability when operating equipment.

Safety Conscientiousness

Assesses the candidate's tendency to display thorough and assiduous behavior and avoid rule breaking, group pressure, negative norms or casual acceptance of other's performance to ensure safe outcomes.

Perception and Comprehension

Perception and comprehension is assessed at both visual and textual level in varying contexts including low contrast, detail perception, verbal ideation, sequencing of objects and identification with distraction. High scoring candidates are able to detect the unusual in both textual and visual formats, leading to increased ability to distinguish potential hazards in their immediate environment.

Positive Coping Skills

Addresses the constancy of the candidate's mental disposition and affects of mood on safety behavior. Impact of mood on alertness, maintenance of situational awareness, responsiveness and diligence is considered.

Defensive Safety Habits

Safety habits assessed include the capacity to monitor developments with the self and environment including weather, fatigue and personality issues. High scorers can be seen to test assumptions, verify understanding, ask pertinent questions and self monitor workload leading to greater capacity to anticipate future events.

Team and Road Safety Orientation

Assesses the inclination and capacity for the individual to demonstrate regard and consideration for other mobile equipment users as well as to display patience and encourage safety by example.

Mental Alertness

This scale measures cognitive capacity and an individual's predisposition to failure in mental functioning indicated by everyday slips in perception, physical function and memory. Low scoring candidates in this scale demonstrate a tendency towards uncoordinated behavior, distraction and short term memory failure, leading to vulnerability to errors of omission or increased safety violations due to frustration.

Safety Self Awareness

This scale identifies the candidate's knowledge of the effects of various stressors in reducing mental capacity and ability to maintain alertness on the job.

Responsible For Safety

This scale assesses an individual's perception of their ability to direct and influence safety outcomes for themselves and others. Behavior array with regard to safety ranges from passive to proactive.

General Hazard Awareness

Designed to gauge the candidate's ability to identify hazardous circumstances, this scale tests alertness and understanding of basic safety issues. The scale consists of a sequence of workplace contexts representing specific machinery, housekeeping and careless behavior risks.

KEY AVIATION SSA VERSIONS

SSA Functional Generic: This 75 question inventory tests ability to perform at a level equivalent of a normal adult. The instrument is used to assess mental functioning and basic capacity for safe behavior in personnel with little workplace experience or safety training. (E.g. Apprentices)

SSA Industrial: A 115 question survey assessing mental state, preferred behavior and competencies with regard to safety. This is used to assess the probability of safe behavior of people working in operational roles. (Eg: Aircraft maintenance personnel)

SSA Ground Crew: A 70 item test of mental functioning and capacity for safety at the level of an alert normal adult. Used for assessment of personnel operating in a fast paced airport ramp environment.

SSA Cabin Crew: This 85 question survey assesses capacity to maintain presence of mind, recover from adverse personal events, apply appropriate emergency management procedures and manage passengers in flight.

SSA Trainee Aircrew: A 75 question test of ability to perform at the level of a well functioning normal adolescent or adult, relative to the growing performance required of a professional pilot in training.

SSA Professional Aircrew: This 175 question test assesses abilities and perception relative to performance required of an optimally professional pilot. The instrument primarily assesses mental functioning and basic capacity for safe behavior for pilots in charter or regular public transport operations.

BST Inventory (Admin): This 65 question test of ability to perform at the level of a well functioning normal adolescent or adult is used to assess the capacity for safe behavior in low personal risk environments. This test can be used to assess employees with planning and scheduling functions.

SSA Resilience Extension: This 66 item diagnostic instrument further assesses specific capability in managing personal and workplaces stress, fatigue and responsiveness relative to the maintenance of situational awareness and performance in the workplace.

DELIVERING THE SSA TEST

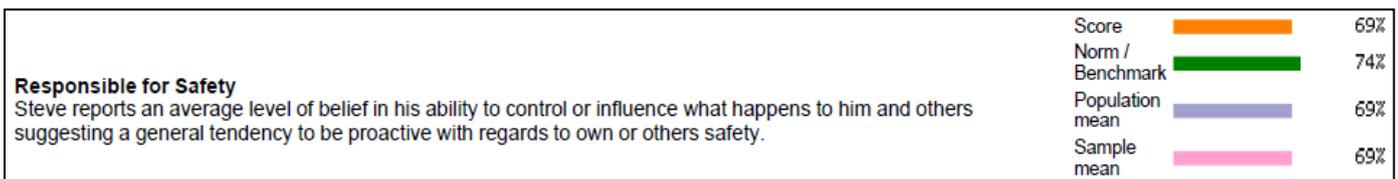
The multidimensional selection of scales making up each SSA version are weighted according to criteria determined by comparative tests and subject matter experts to reflect the adequacy of the measured attribute and then further compared to samples of negligible incident rate individuals.

To prevent biasing of the AAI score toward less important test items, a system of bonuses and penalties are applied to the final score to achieve an objective and logical result. Additionally, individual scale results have an acceptable margin of approximately 7-9% of the criterion score.

The acceptable cutting score (AAI) is set by the organization. However, an existing and generally accepted cutting score of 60 was found to correspond over a 14 month period to those with less than 10% of total incidents and less loss than others in the study sample.

As the majority of SSA tests are delivered unsupervised, several defensive measures have been included to guarantee accuracy of the results with repeated testing, and to prevent information sharing by test users. To inhibit the learning effect, it is advisable not to deliver repeat attempts within seven days. Successive delivery to the same individual is undertaken by delivery of an alternate form of the test with a reordered question set.

In addition to the acceptable cutting score, final reports include a micro interpretation of the respondents individual scale score relative to the criteria or norm, and a graphical representation of the respondents score relative to the criteria, population mean, and the mean of a selected sample.



Additional interview guides are also provided as a secondary means of analyzing responses to key clusters of questions within the test. This is to allow comparisons of specific test proportions whose significance may be masked within an overall acceptable scale score.

<p>● Impression Management - Caution - Inconsistency in Responses Exceeds Normal Range Steve seems to have experienced some difficulty in providing consistent responses to questions resulting in a degree of contradiction in 'self reported' behaviour. You may wish to explore if this is a simple matter of poor language skills, difficulty in interpretation, a lack of candidness, confused or random responding or a lack of conviction about things. Note that the respondent's desire to manage the impression they are making, may also produce this result.</p> <p>Failure of Presence of Mind Steve's responses are suggestive of some tendency to a failure of 'presence of mind' or situational awareness. You should explore this further to identify if any fatigue, illness, medication, lifestyle or task and emotional overload related issues could interfere with necessary attention and due vigilance on the job.</p> <p>Makes blunders Steve reports a tendency to uncoordinated , clumsy movements together with a tendency to rash emotional outbursts and inattentiveness. Check low results on the mental alertness and coping scales for verification of a need for further investigation.</p>
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EXAMPLE FULL REPORT

Client: **PROGRESSIVE AVIATION SOLUTIONS**

Results for survey 10270 SSA AVIATION (GROUND) v2.0 = [WIP] completed on 09 / 12 / 11 11:00:52 PM

Respondent name: Steve Person Date of Birth: 21-06-1981

Telephone: 0403300808 Email: progressive_av@optusnet.com.au Address: Unit 7 3-5 Aurelian street Palmyra 6157 WA Australia

Position: GENERAL Location: ALL

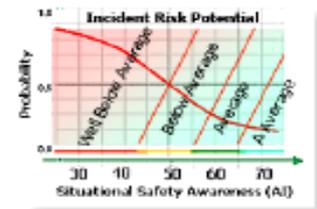
Summary Results

Assessment Index (Overall Score) calculated as: 52 Adjusted Assessment Index: 46
Time taken to complete this survey: 32767 minutes Expected Time: 30 minutes Time adjust: +32737 minutes

RESULTS SUMMARY:

The Situational Safety Awareness test addresses the ability to see and understand external risks and personal vulnerability to failure of attention, vigilance, defense and responsiveness due to a variety of human factors.

Steve's results indicate a below average capacity with respect to the benchmark for safety minded persons, to maintain his situational awareness and master or cope with the safety needs of the role.



Steve reports a greater competency in

- Ability to think ahead, detect errors, avoid pitfalls and infer developing hazards in a situation
- Anticipating the hazardous effect of distractions, fatigue and variable diligence in self and others
- Anticipating the danger in the most common types of workplace safety incidents

Steve's results indicate that caution should be exercised with respect to tasks requiring competent skills in

- The capacity for mental and visual sharpness to detect the unusual or occasional event in common contexts
- Ability to remember and recall 'short term' information when needed
- Rejection of casual acceptance and complacency through a better understanding of the impact of human factors impact on own performance
- Having a good appreciation of the problems of sleep debt and fatigue and the skills to recover performance
- Being able to avoid loss of perception and vigilance with failure of presence of mind

The respondent's risk of loss of situational awareness (SA) can be determined by transferring the Ai score to the 'risk probability curve' on the graph. An Ai score of less than 50 would suggest a greater or growing risk of loss of SA with stress, fatigue and other disruptive factors. An Ai score greater than 55 provides for increasing certainty of safe behaviour.

INTERVIEW GUIDE & ALERTS

There are no interview probes, Alerts or behavioural guides for this result.

FUNCTIONAL ABILITIES

Ability	Score	Norm / Benchmark	Population mean	Sample mean
General Hazard Awareness Steve's results at the above average level indicate a greater ability to identify progressively more complex sequences of work place hazards typically found in mining or large earthwork excavations, as a confirmation of an alertness and significantly greater depth of understanding of workplace safety issues.	80%	67%	80%	80%
Judgement and Speed Steve indicates an average or normal level of ability to operate in a timely coordinated way in the context of perceiving, deciding and responding accurately to a specific stimulus, indicating an adequate level of neurological functioning necessary for safe behaviour.	65%	68%	65%	65%
Perceptual Acuity Steve's results on the basic test of perceptual and cognitive acuity was at the below average level suggesting some difficulty in distinguishing unusual differences or objects in the environment that may represent a hazard.	41%	66%	41%	41%
Reasoning & Logic Steve indicates an above average ability to plan, organise, project outcomes and discern a logical sequence in both practical and abstract tasks. Contributing significantly to Steve's safety mindfulness and capacity to avoid risk.	80%	65%	80%	80%
Working Memory Steve's results were at the below average level in maintaining a level of memory functioning involving short term situationally specific or episodic retrieval, indicating a lesser capacity to retrieve and manipulate data when it is needed when under stress or urgency, for the safe execution of a task.	9%	50%	9%	9%

PERSONAL STATUS

Ability	Score	Norm / Benchmark	Population mean	Sample mean
Emotional Resilience (Typical Coping) Steve reports a mostly adequate and normal level of emotional stability and capacity to remain positive, generally showing a capacity to manage daily situationally based events that could generate some anxiety or reactive depression. He would try to avoid projecting overt dissatisfaction by being critical of others or of complaining about things. Steve's general presentation would be generally marked by an attempt to maintain perspective and make light of things.	65%	70%	65%	65%

EMPIRICAL RATIONALE

Extensive research in the area of human performance and safety form the basis of the SSA's validation. Overall the basic SSA instrument demonstrates a mean test reliability of the scales at an alpha of 0.86 for 743 respondents.

Each of the competency scales were assessed against measures of relevance, importance and frequency in the perception and hazard identification scales. Only items meeting the criteria of moderate difficulty and high discrimination were engaged. Scales for perception and comprehension were included to fulfill the need for combined visual and cognitive activity measures with diagnostic capability.

Reliability for the scales was calculated using Chronbach's alpha and a sample size of 743 adults. Scale item correlations and reliabilities were established against other well regarded instruments to reinforce the validity measuring certain attributes indicating the reliability of the scales psychometric properties⁷.

SSA Scale Reliabilities	
Safety Competency	Reliabilities
(Ability)	Alpha
Hazard Awareness	0.92
Perception and Comprehension	0.89
Safety Habits	0.90
Understanding Fatigue	0.94
Safety Perspectives (Attitudes)	
Team Safety Orientation	0.73
Responsible for safety	0.86
Safety Conscientiousness	0.78
Risk Avoidance	0.80
Personal Status (Mental State)	
Coping Skill	0.86
Mental Alertness	0.89
<u>Rosenweg (2011)</u>	

Some improvement was shown during test-retest analysis due to the learning effect experienced on scale items over a 2 week period. In 2005-2006 reliabilities were re-calculated due to changes to some items and the inclusion of additional scales.

Cross scale correlations and reliabilities to measure the accuracy and repeatability of the questionnaire items in obtaining reliable responses to the personal status and attitude scales were conducted by Rosenweg,⁷ and Goldberg.⁸

⁷ Rosenweg, P. (2011), Assessing Situational Safety Awareness; Engineering Safety Resilience with the SSA Inventory. Melbourne, Australia: Psyfactors.

⁸ Goldberg, L.R. (2001) IPIP. A Scientific Collaboratory for the Development of Advanced Measures of Personality Traits and Other Individual Differences. <http://ipip.ori.org/>



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