CIVIL AVIATION SAFETY AUTHORITY
OF PAPUA NEW GUINEA

Advisory Circular

AC 100-02

Human Factors Guidelines for the Aviation Industry

Initial Issue

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GENERAL

Civil Aviation Safety Authority Advisory Circulars (AC) contain information about standards, practices and procedures that the Director has found to be an Acceptable Means of Compliance (AMC) with the associated rule.

An AMC is not intended to be the only means of compliance with a rule, and consideration will be given to other methods of compliance that may be presented to the Director. When new standards, practices or procedures are found to be acceptable, they will be added to the appropriate Advisory Circular.

This Advisory Circular also includes Explanatory Material (EM) where it has been shown that further explanation is required. Explanatory Material must not be regarded as an acceptable means of compliance.

PURPOSE

The purpose of this Advisory Circular is to provide information and guidance relating to human factors principles. Organisations seeking certification are required, under Civil Aviation Rules, to have such procedures in place. Any organisation requiring a Certificate under Civil Aviation Rules can apply the procedures and practices outlined in this AC.

RELATED CAR

This AC relates to CAR Parts 100, 109, 119, 129, 139, 140, 141, 145, 146, 171, 172, 173, 174, and 175.

CHANGE NOTICE

There was no previous issue of this AC, consequently no change is in effect.

APPROVAL

This Advisory Circular has been approved for publication by the Director of Civil Aviation.

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1. ACRONYMS

AC	Advisory Circular
AMC	Acceptable Means of Compliance
ATC	Air Traffic Control
ATM	Air Traffic Management
CAA	Civil Aviation Authority
CAP	Civil Aviation Publication
CAR	Civil Aviation Rule (PNG)
CASA	Civil Aviation Safety Authority
CNS	Communication, Navigation System
CRM	Crew Resource Management
EASA	European Aviation Safety Agency
EM	Explanatory Material
FAA	Federal Aviation Administration (USA)
FAR	Federal Aviation Regulations (USA)
GACA	General Authority of Civil Aviation
HF	Human Factors
ICAO	International Civil Aviation Organisation
L-E	Liveware-Environment (interface)
L-H	Liveware-Hardware (interface)
L-L	Liveware-Liveware (interface)
LOFT	Line Oriented Flight Training
L-S	Liveware-Software (interface)
MRM	Maintenance Resource Management
MRO	Maintenance Repair Organisation
MxHF	Maintenance Human Factors
OJT	On-the-Job
SHELL	Software-Hardware-Environment-Liveware-Liveware
SMM	Safety Management Manual
SMS	Safety Management System
SOPs	Standard Operating Procedures
TC	Transport Canada
TEM	Threat and Error Management
TRM	Team Resource Management
UKCAA	United Kingdom CAA

2. DEFINITIONS

ACUTE STRESS – is a psychological condition that arises from real time demands placed on our senses, or witnessing a traumatic event that induces a strong emotional response within an individual.

CERTIFICATE HOLDER – is an aviation organisation exercising privileges under the certificates issued by CASA PNG certification rules.

CHRONIC STRESS - is the response to emotional pressure suffered for a prolonged period of time in which an individual perceives he or she has little or no control.

CIRCADIAN RHYTHM - is basically a 24-hour internal (body) clock that is running in the background of your brain and cycles between sleepiness and alertness at regular intervals. It's also known as your sleep/wake cycle.

CREW RESOURCE MANAGEMENT (CRM) - Team-based human factors (HF) training focusing on effective use of all available resources: human resources, hardware, and information.

ERGONOMICS - The applied science having the objective of adapting work, working conditions, and equipment to enhance performance of the worker.

HUMAN ERROR - are the result of human actions that fail to generate the intended outcomes. They are categorized according to the cognitive processes involved towards the goal of the action and according to whether they are related to planning or execution of the activity.

HUMAN FACTORS - Human Factors (HF) is a multidisciplinary field that generates and compiles information about human capabilities and limitations, and applies it to design, development, and evaluation of equipment, systems, facilities, procedures, jobs, environments, staffing, organizations, and personnel management for safe, efficient, and effective human performance.

HUMAN PERFORMANCE - means human capabilities and limitations which have an impact on the safety, security and efficiency of aeronautical operations.

HUMAN FACTORS PRINCIPLES - means principles which apply to design, certification, training, operations and maintenance and which seek safe interface between the human and other system components by proper consideration to human performance.

HUMAN FACTORS TRAINING – is the study of Human Factors in understanding human behaviour and performance. When applied to aviation operations, Human Factors knowledge is used to optimize the fit between people and the systems in which they work in order to improve safety and performance.

ICAO ANNEX - means an Annex to the Convention and unless otherwise specified in a rule, includes the amendments in force under section 78 of the Act, but excludes any differences to an Annex as notified by Papua New Guinea.

ICAO DOC – An **ICAO document** is just something the ICAO organization has chosen to publish in its Doc Series with an identifying number for ease of reference. Being an "ICAO Document" doesn't in itself say anything about who wrote it or its legal force. For example, Doc 7300 is the Chicago Convention itself, which has a lot of force (but not because it has a Doc number), whereas Doc 9562, *Airport Economics Manual* is more informative in nature and tries to be persuasive rather than authoritative

LEADERSHIP - The ability to direct and coordinate the activities of group members and stimulate them to work together as a team.

MAINTENANCE RESOURCE MANAGEMENT (MRM) - A general process for maintaining an effective level of communication and safety in maintenance operations. This term was more widely used in the 1990s than currently. In comparison, the term Maintenance Human Factors (MxHF) is more descriptive, all-encompassing, and widely used.

ORGANISATIONAL FACTORS - are job factors, along with human and individual characteristics, that influence behaviour at work in a way that can affect the performance of an employee.

PEER PRESSURE - is the direct influence on people by peers, or the effect on an individual who gets encouraged to follow their peers by changing their attitudes, values or behaviours to conform to those of the influencing group or individual.

REPORTING SYSTEM – a system for collecting human factors problem reports to establish a database to guide activities for enhancing aviation safety.

SAFETY CULTURE - A pervasive, organization-wide attitude placing safety as the primary priority driving the way employees perform their work.

SAFETY MANAGEMENT SYSTEM (SMS) - A formal, top-down business approach to managing safety risk, which includes a systematic approach to managing safety, including the necessary organizational structures, accountabilities, policies, and procedures.

SAFETY ZONES – is a "do not disturb" area around workers engaged in critical tasks.

SHELL MODEL - is a conceptual model of human factors that clarifies the scope of aviation human factors and assists in understanding the human factor relationships between the aviation system elements (SHEL) and the human element (L) in the aviation system.

THREAT AND ERROR MANAGEMENT – is the process of detecting and responding to threats and errors to ensure that the ensuing outcome is inconsequential.

WORKPLACE CULTURE – means the way things are done in an organisation which become norms. This practices develop over time and can be both good and bad, safe and unsafe.

3. APPLICABILITY

This advisory circular is applicable to all civil aviation organisations exercising privileges under the certificates issued by the following rule parts:

- Regulated Air Cargo Agent (CAR 109)
- Air Operator (CAR 119)
- Foreign Air Operator (CAR 129)
- Aerodromes (CAR 139)
- Aviation Security Service Organization (CAR 140)
- Aviation Training Organization (CAR 141)
- Aircraft Maintenance Organization (CAR 145)
- Aircraft Design Organization (CAR 146)
- Aeronautical Telecommunication Service Organization (CAR 171)
- Air Traffic Service Organization (CAR 172)
- Air Navigation Service Organization (CAR 173)
- Aviation Meteorological Service Organization (CAR 174)
- Aeronautical Information Service Organization (CAR 175)

The Human Factors requirement is captured in Civil Aviation Rule (CAR) Part 100 and affects all the relevant CARs listed above.

4. BACKGROUND

The current aviation system is considered to be one of the safest industries in the world with thousands of successful operations every day. The entire aviation system relies on the behaviours and performance of individuals and teams for safety, efficiency and effectiveness. However, human error continues to be cited as a major factor in aviation accidents and incidents. Successfully addressing human error must consider that error is often a symptom of systemic and organisational issues, with multiple factors involved that affect human performance.

Human Factors is "anything that affects human performance", and it cuts across the entire aviation system. Finding ways to improve human performance can have a significant positive impact on aviation safety and operational effectiveness. The Civil Aviation Safety Authority of Papua New Guinea (CASAPNG) recognises this, and has integrated human factors requirements into its regulations to

ensure that human factors principles are recognised and practised within the aviation industry in Papua New Guinea.

5. AIMS AND OBJECTIVES

The overall aim is to improve aviation safety and operational effectiveness through integrating human factors in all aviation activities. The objectives are to:

- Recognise the positive and negative role of human performance in aviation safety and operational effectiveness.
- Encourage implementation of human factors principles in aviation activities.
- Apply and incorporate human factors principles in safety analysis and safety management, and facilitate the use of appropriate methods and metrics.
- Educate and inform the aviation workforce, including pilots, controllers, maintainers, designers, ground-operators, managers, and others about human factors and lessons learnt in safety and operations.
- Support research to provide human factors data for future aviation safety and operational needs.
- Ensure appropriate action is taken when known human performance related risks are identified

Effective Human performance is fundamental to operational safety in aviation. It needs to be integrated into all aspects of aviation including equipment and system design, procedures, training and competency, etc. and should not be considered in isolation.

6. AVIATION INDUSTRY

It is intended that any person or organisation involved in the aviation industry understands and applies human factors in all activities and operations. These include:

- Addressing human factors in organisational activity and service provision
- Addressing human factors in system design
- Implementing open and voluntary reporting systems
- Collection and analysis of data
- Investigations of events to identify both technical and HF causal and contributing factors
- Identifying and mitigating human performance related risks
- Development of effective interventions (both human and technical)
- Integrating human factors into the Organisation's Safety Management System (SMS), to include positive and pro-active indicators of operational safety
- Providing an appropriate level of human factors training to staff including management **(See core elements of human factors training program in chapter 7)**

7. SHELL MODEL OF HUMAN FACTORS

The **SHELL Model** is defined as "*the relationship of human factors and the aviation environment*"

This concept has originated from the 'SHEL Model' by Edwards in 1972, which the name was derived from the initials of its components (Software, Hardware, Environment, and Liveware). In 1975, Hawkins developed the concept into the 'SHELL Model' with an introduction of another Liveware into the original concept, 'SHEL Model'.

The most different point between Edwards's SHEL Model (1972) and Hawkins's SHELL Model (1975) is that Hawkins urged for the necessity of another 'Liveware' (the person) and diagrammed to illustrate the interactions between the central Liveware and each of other four systems.

It is generally known that most of the air accidents are related to human errors, while the mechanical failures in aircraft maintenance today has enormously been on the decrease with a number of new high technological equipment inventions.

Furthermore, in the perception of human factors, every individual, either who takes part in the operation or the supporting part of aviation, has individual capabilities and limitations. Thus, many countries in the world strive to secure the safety by training based on the interactions of each of SHELL components.

Most importantly, the SHELL model places more emphasizes on the interfaces between a person (centre Liveware) and the other four components rather than its components themselves. On the other side, it is inapplicable in this model to cover the interfaces which are outside human factors such as Hardware-Hardware, Environment-Software.

From this SHELL model, each person (Centre Liveware) is applied to and interacted with the other four components and the different interactions between the person and each of other components considered as the human possibility, while it is believed from this theory that a mismatch between the centre Liveware and any other four components always leads to a source of human error.

Interrelationship between human factors and the aviation environment

7.1 SHELL ELEMENTS

The main elements in the model can be listed as follows:

Hardware

Physical elements of the aviation system such as aircraft (including controls, surfaces, displays, functional systems and seating), operator equipment, tools, materials, buildings, vehicles, computers, conveyor belts etc.

Software

- Non-physical, intangible aspects of the aviation system that govern how the aviation system operates and how information within the system is organised.
- Software may be likened to the software that controls the operations of computer hardware.
- Software includes rules, instructions, regulations, policies, norms, laws, orders, safety procedures, standard operating procedures, customs, practices, conventions, habits, symbology, supervisor commands and computer programmes.
- Software can be included in a collection of documents such as the contents of charts, maps, publications, emergency operating manuals and procedural checklists.

Environment

The Environment includes not only the factors which influence where people are working such as climate, temperature, vibration and noise, but also socio-political and economic factors.

Liveware

- Human element or people in the aviation system. For example, flight crew personnel who operate aircraft, cabin crew, ground crew, management and administration personnel.
- The liveware component considers human performance, capabilities and limitations

Central Liveware

The Liveware, which is in the centre of the SHELL Model, can be defined as human elements such as knowledge, attitudes, cultures and stress. This Liveware is regarded as the core of the SHELL Model and other components match with the Liveware as the central figure.

7.2 SHELL INTERFACES

L-H System (Liveware-Hardware)

Firstly, the interaction between the Liveware and the Hardware (L-H system) is usually named man-machine system. This system can be easily explained by an example which aircrafts should provide a great value of services as much as they can, such as fitting seat in aircraft, for the passenger's comfortable flight.

The design of controls and displays, which is subject to the L-H interaction, should be matched with human characteristics and conveniences in order to minimize the possibility of L-H error occurrences. In addition, the errors originated from the deficiency of this L-H interaction are commonly seen when human factor specialists only consider the design on the in-flight control and display leading to the common errors.

Some research in 1940s showed an instance of the common error of L-H interface that the old three-pointer altimeter had caused common errors in aviation field. Therefore, displays should indicate information that people can process their tasks in order to successfully minimize the occurrence of the error, such as knowledge of human behaviour and the way that people can process information, make decisions and act on them.

L-S System (Liveware-Software)

The second interface, in the SHELL Model, is represented as the interaction between the Liveware and Software. As the Software indicates intangible objects than those of the Hardware, it is clear that the error of L-S interaction is more difficult to solve than the error of L-H interaction.

The deficiencies conceptual aspects of warning system can be applied to the L-S interface and it can lead to an irrational indexing system in the manual operations to the delaying or errors when people seek vital information.

For example, in the past, some early checklists did not have any written responses for the specific situation change on the lists and the pilots at the time did not check the checklists properly. To reduce the error of L-S interaction, a solution was found, which is called SOPs. However, SOPs is not for every possible condition, but for some flexibility.

L-E System (Liveware-Environment)

The efforts toward the error of this L-E interaction is well shown from flight instruments, which help overcome obstacles of flight, like helmet against the noise, flying suit against the cold, goggles against the effects of altitude.

Additionally, this L-E interface is concerned on the organisational, regulatory and socio-aspects of environment like the morale of employees and the health of organization in the aviation field. Emphasized is placed on the three environmental factors: noise, heat and vibration, which can result in the error of L-E interaction. These errors can be minimised through optimising control of those three factors as many successful research have been shown.

L-L System (Liveware-Liveware)

Finally, there is the last interface in the SHELL Model, which is the interaction between the Liveware and Liveware. This L-L interface is also related to leadership, crew cooperation and personality interaction and human factors experts have ascertained that, the problems of L-L interaction, such as errors within team-work, had caused a great deal of accidents.

Possible solutions in terms of L-L interaction, which are CRM (Cockpit/crew Resource Management), TRM (Team Resource Management), and LOFT (Line Oriented Flight Training). He also determined that these effective training programmes on crew members towards better cooperation and communication would build considerable reductions in the occurrences of L-L error.

8. DIRTY DOZEN OF HUMAN FACTORS

The Dirty Dozen refers to twelve of the most common human error preconditions, or conditions that can act as precursors, to accidents or incidents. These twelve elements influence people to make mistakes. The Dirty Dozen is a concept developed by Gordon Dupont, in 1993, whilst he was working for Transport Canada (TC), and formed part of an elementary training programme for Human Performance in Maintenance. It has since become a cornerstone of Human Factors in Maintenance training courses worldwide, as exemplified in UKCAA CAP715.

The Dirty Dozen is not a comprehensive list of human error accident precursors, for example, ICAO Circular 240-AN/144 lists over 300 human error precursors. However, since 1993 all areas of the aviation industry, not just aircraft maintenance, have found the Dirty Dozen a useful introduction to open

discussions into human error in their businesses, organisations and workplaces. So, it may be possible to find Dirty Dozen lists for pilots, ramp workers, air traffic controllers and cabin crew.

The List

The original list, developed for aircraft maintenance, is available in many documents, one good example is TC14175, and this list is used as the basis for this entry. There is no order of priority.

1. Lack of Communication	5. Lack of Teamwork	9. Lack of Assertiveness
2. Complacency	6. Fatigue	10. Stress
3. Lack of Knowledge	7. Lack of Resources	11. Lack of Awareness
4. Distraction	8. Pressure	12. Norms

1. Lack of Communication

Poor communication often appears at the top of contributing and causal factors in accident reports, and is therefore one of the most critical human factor elements. Communication refers to the transmitter and the receiver, as well as the method of transmission. Transmitted instructions may be unclear or inaccessible. The receiver may make assumptions about the meaning of these instructions, and the transmitter may assume that the message has been received and understood. With verbal communication it is common that only 30% of a message is received and understood.

Detailed information must be passed before, during and after any task, and especially across the handover of shifts. Therefore, when messages are complex they should be written down, and organisations should encourage full use of logbooks, worksheets, and checklists etc. Verbal messages can be kept short, with the most critical elements emphasised at the beginning and repeated at the end. Assumptions should be avoided and opportunities for asking questions both given and taken.

2. Complacency

Complacency can be described as a feeling of self-satisfaction accompanied by a loss of awareness of potential dangers. Such a feeling often arises when conducting routine activities that have become habitual and which may be “considered”, by an individual (sometimes by the whole organisation), as easy and safe. A general relaxation of vigilance results and important signals will be missed, with the individual only seeing what he, or she, expects to see. Complacency can also occur following a highly intense activity such as recovering from a possible disaster; the relief felt at the time can result in physical relaxation and reduced mental vigilance and awareness. This particular psychological experience is referred to as a Lacuna.

Whilst too much pressure and demand causes over-stress and reduced human performance, too little results in under-stress, boredom, complacency and reduced human performance. It is therefore important, when conducting simple, routine and habitual tasks, and when fatigued, to maintain an adequate, or optimum, level of stress through different stimulation. Always expect to find a fault! Following written instructions, and adhering to procedures that increase vigilance, such as inspection routines, can provide suitable stimulus. It is important to avoid: working from memory; assuming that something is ok when you haven’t checked it; and signing off work that you are unsure has been completed. Teamwork and mutual cross-checking will provide adequate stimulus when fatigued.

3. Lack of Knowledge

The regulatory requirements for training and qualification can be comprehensive, and organisations are forced to strictly enforce these requirements. However, lack of on-the-job (OJT) experience and specific knowledge can lead workers into misjudging situations and making unsafe decisions. Aircraft systems are so complex and integrated that it is nearly impossible to perform many tasks without substantial technical training, current relevant experience and adequate reference documents. Furthermore, systems and procedures can change substantially and employees' knowledge can quickly become out-of-date.

It is important for employees to undertake continuing professional development and for the most experienced workers to share their knowledge with colleagues. Part of this learning process should include the latest knowledge on human error and performance. It should not be a taken as a sign of weakness to ask someone for help or for information, in fact this should be encouraged. Checklists and publications should always be referred to and followed, and never make assumptions or work from memory.

4. Distraction

Distraction could be anything that draws a person's attention away from the task on which they are employed. Some distractions in the workplace are unavoidable, such as loud noises, requests for assistance or advice, and day-to-day safety problems that require immediate solving. Other distractions can be avoided, or delayed until more appropriate times, such as messages from home, management decisions concerning non-immediate work (e.g. shift patterns, leave entitlement, meeting dates, administrative tasks etc), and social conversations.

Psychologists say that distraction is the number one cause of forgetting things, hence the need to avoid becoming distracted and to avoid distracting others. Humans tend to think ahead. Thus, when returning to a task, following a distraction, we have a tendency to think we are further ahead than we actually are. To reduce errors from distraction it is best to complete a task before responding. If the task cannot be completed without hurrying, then we can prominently mark (or, "lock off") the incomplete work as a reminder to ourselves and anyone else who may complete the work. When returning to work, after being distracted, it is a good idea to commence at least three steps back, so that we re-trace some steps before picking up the task again. If necessary, having someone else double-check our work using a checklist may be appropriate and useful.

Management have a role to play in reducing the distractions placed on their employees. This may involve good workspace design, management of the environment, and procedures that create "safety zones", "circles of safety" or "do not disturb areas" around workers engaged in critical tasks.

5. Lack of Teamwork

In aviation many tasks and operations are team affairs; no single person (or organisation) can be responsible for the safe outcomes of all tasks. However, if someone is not contributing to the team effort, this can lead to unsafe outcomes. This means that workers must rely on colleagues and other outside agencies, as well as give others their support. Teamwork consists of many skills that each team member will need to prove their competence.

Some of the key teamwork skills include: leadership, followership, effective communication, trust building, motivation of self and others, and praise giving.

To create an effective team it is necessary that the following issues, as appropriate, are discussed, clarified, agreed, and understood by all team members:

- A clearly defined and maintained aim, or goal(s)
- Each team member's roles and responsibilities
- Communication messages and methods
- Limitations and boundaries
- Emergency procedures
- Individual expectations and concerns
- What defines a successful outcome
- Debriefing arrangements
- Team dismissal arrangements
- Opportunities for questions and clarification

A team's effectiveness can also be improved through the selection of team members to reflect a broad range of experience and skill sets, and also through practice and rehearsal.

6. Fatigue

Fatigue is a natural physiological reaction to prolonged physical and/or mental stress. We can become fatigued following long periods of work and also following periods of hard work. When fatigue becomes a chronic condition it may require medical attention but, workers should never self-medicate! As we become more fatigued our ability to concentrate, remember and make decisions reduces. Therefore, we are more easily distracted and we lose situational awareness. Fatigue will also affect a person's mood, often making them more withdrawn, but sometimes more irrational and angry.

It is a human problem that we tend to underestimate our level of fatigue and overestimate our ability to cope with it. Therefore, it is important that workers are aware of the signs and symptoms of fatigue – in themselves and others. Fatigue self-management involves a three-sided programme of regular sleep, healthy diet (including reduced use of alcohol and other drugs), and exercise. Work of a critical and complex nature should not be programmed during the low point on the body's circadian rhythm (usually 03:00 – 05:00am); and, when fatigued always get someone else to check your work.

7. Lack of Resources

If all the parts are not available to complete a maintenance task, then there may be pressure on a technician to complete the task using old, or inappropriate parts. Regardless of the task, resources also include personnel, time, data, tools, skill, experience and knowledge etc. A lack of any of these resources can interfere with one's ability to complete a task. It may also be the case that the resources available, including support, are of a low quality or inadequate for the task.

When the proper resources are available, and to hand, there is a greater chance that we will complete a task more effectively, correctly and efficiently. Therefore, forward planning to acquire, store and locate resources is essential. It will also be necessary to properly maintain the resources that are available; this includes the humans in the organisation as well.

8. Pressure

Pressure is to be expected when working in a dynamic environment. However, when the pressure to meet a deadline interferes with our ability to complete tasks correctly, then it has become too much. It is the old argument of Quantity versus Quality; and in aviation we should never knowingly reduce the quality of our work. Pressure can be created by lack of resources, especially time; and also from our own inability to cope with a situation. We may come under direct, or indirect, pressure from the Company, from clients and even our colleagues. However, one of the most common sources of pressure is ourselves. We put pressure on ourselves by taking on more work than we can handle, especially other

people's problems, by trying to save face, and by positively promoting super powers that we do not possess. These poor judgements are often the result of making assumptions about what is expected of us.

Learning assertiveness skills will allow a worker to say 'No', 'Stop!', and communicate concerns with colleagues, customers and the Company. These skills are essential, and when deadlines are critical, then extra resources and help should always be obtained to ensure the task is completed to the required level of quality

9. Lack of Assertiveness

Being both unable to express our concerns and not allowing other to express their concerns creates ineffective communications and damages teamwork. Unassertive team members can be forced to go with a majority decision, even when they believe it is wrong and dangerous to do so.

Assertiveness is a communication and behavioural style that allows us to express feelings, opinions, concerns, beliefs and needs in a positive and productive manner. When we are assertive we also invite and allow others to assert themselves without feeling threatened, undermined or that we've lost face. Speaking one's mind assertively is not to be confused with aggression. It is about communicating directly, but honestly and appropriately; giving respect to the opinions and needs of others, but not compromising our own standards.

Assertiveness techniques can be learnt and they focus on keeping calm, being rational, using specific examples rather than generalisations, and inviting feedback. Most importantly, any criticisms should be directed at actions and their consequences rather than people and their personalities; this allows others to maintain their dignity, and a productive conclusion to be reached.

10. Stress

There are many types of stress. Typically in the aviation environment there are two distinct types - acute and chronic. Acute stress arises from real-time demands placed on our senses, mental processing and physical body; such as dealing with an emergency, or working under time pressure with inadequate resources. Chronic stress is accumulated and results from long-term demands placed on the physiology by life's demands, such as family relations, finances, illness, bereavement, divorce, or even winning the lottery. When we suffer stress from these persistent and long-term life events, it can mean our threshold of reaction to demands and pressure at work can be lowered. Thus at work, we may overreact inappropriately, too often and too easily.

The situation of stress arising from lack of stimulation at work has been covered above under Complacency above.

Some early visible signs of stress include changes in personality and moods, errors of judgement, lack of concentration and poor memory. Individuals may notice difficulty in sleeping and an increase in fatigue, as well as digestive problems. Longer-term signs of stress include susceptibility to infections, increased use of stimulants and self-medication, absence from work, illness and depression.

It is important to recognise the early signs of stress and to determine whether it is acute or chronic. Coping with daily demands at work can be achieved with simple breathing and relaxation techniques. However, perhaps more effective is having channels of communication readily available through which to discuss the issue and help to rationalise perceptions. It is entirely appropriate that some of these channels involve social interaction with peers. As with fatigue, sleep, diet and exercise are all important factors in helping to reduce stress and build resilience to stressors. If the stress is chronic, then definite lifestyle changes will be required; this must be achieved with support from the Company. Companies

ought therefore, to have employee assistance (or wellbeing) policies that include stress reduction programmes.

11. Lack of Awareness

Working in isolation and only considering one's own responsibilities can lead to tunnel vision; a partial view, and a lack of awareness of the affect our actions can have on others and the wider task. Such lack of awareness may also result from other human factors, such as stress, fatigue, pressure and distraction.

It is important to build experience throughout our careers, especially concerning the roles and responsibilities of those we work with, and our own place in the wider Team. Developing our foresight is essential in pre-empting the affects our actions may have on others. This is an attitude of professionalism and involves constant questioning *"what if …?"* Asking others to check our work and challenge our decisions is useful in gaining the relevant experience and expanding our awareness. Vigilance is closely related to situational awareness, and workplace procedures, such as scanning, two-way communication and use of checklists will help to maintain vigilance.

12. Norms

Workplace practices develop over time, through experience, and often under the influence of a specific workplace culture. These practices can be both, good and bad, safe and unsafe; they are referred to as "the way we do things round here" and become Norms. Unfortunately such practices follow unwritten rules or behaviours, which deviate from the required rules, procedures and instructions.

These Norms can then be enforced through peer pressure and force of habit. It is important to understand that most Norms have not been designed to meet all circumstances, and therefore are not adequately tested against potential threats.

Rules and procedures should have been designed and tested, and therefore ought to be enforced and followed rigorously. Where workers feel pressure to deviate from a procedure, or work around it, then this information should be fed back so that the procedure can be reviewed and amended, if necessary. Developing assertiveness can allow workers to express their concerns about unsafe Norms, despite peer pressure.

9. HUMAN FACTORS TRAINING

Human factors training can address many issues which causes incidents or accidents during the day to day operations. The training provides necessary knowledge to understand the principles and procedures which should be integrated into the work environment. The human factors training in the important areas of operations increases the awareness levels of the personnel working in the corresponding environment.

Human factors training is an important aspect for effective operations because:

- Human Factors training creates and reinforces a positive safety culture in the working environment.
- The human factors training is necessary to identify methods to recognize, understand and manage human performance issues.
- The work performance and the mental health of the work force is improved as a result of human factors training.

- The training should emphasize on the new regulations, procedures and the equipments, thus providing awareness to the workforce involved and thereby contributing to the increase in efficiency of the job performance.
- A personnel can be able to learn about the cause of an incident through a human factors training program, hence reducing the chances of occurrence of any error.

There are a number of elements that need to be considered in the development of a Human Factors training program. These should be tailored around the specific aviation industry sector, but should include:

	FACTOR	ELEMENTS
1	**Threats and Errors**	• Definitions of Human Error • Definition of threat • Definition of threat and error management • Types of threat and errors • Threat identification • Threat management strategies • Error chain • Error prevention and detection • Error management strategies
2	**Organisational Factors**	• Definition of safety culture • Elements of positive safety culture • Reporting system as a function of overall safety management • Use of safety data to rectify problems and reduce risks • Organisational factors, latent risks • Organisational risk tolerance • SOPs development based on human factors • Company culture re SOP adherence
3	**Stress and Fatigue**	• Definition of stress, stress management, and fatigue • Identify stress • Effects of stress • Stress management techniques • Fatigue and tiredness - causes and symptoms • Circadian rhythms, biological clock, jet lag, etc.
4	**Fatigue Risk Management Systems**	• Management of fatigue at the individual and organisational levels
5	**Information acquisition and processing**	• Definition of information acquisition, information processing • Stages of information processing • Attention and perception • Types of memory • Limitations and failures of memory • Techniques for improving/enhancing memory • Skill development

	FACTOR	ELEMENTS
6	**Situational Awareness and Workload Management**	• Definition of situational awareness and workload management • Types of situational awareness • Components of situational awareness • Activities to achieve situational awareness • Loss of situational awareness - recognition and recovery • Capacity limitations and cognitive overload • Workload management strategies • Prioritisation • Managing distractions
7	**Decision Making**	• Definition of decision making • Factors affecting decision making • Bias • Types of decision making • Option generation • Decision making skills • Problem solving techniques • Risk management
8	**Communication**	• Definition of communication • Modes of communication • Factors affecting communication / barriers to effective communication • Standard phraseology • Listening • Communication styles and techniques • Internal and external communication • Briefings
9	**Leadership and team behaviour**	• Definition of leadership and authority • Attributes and qualities of good leaders • Assertiveness • Authority gradient • Identify factors affecting team performance • Define Crew Resource Management • Methods of optimising CRM • Group decision making – advantages and disadvantages • Cooperation and team building • Concept of management • Conflict resolution • Cultural differences
10	**Automation, vigilance and monitoring**	• Definition of automation, vigilance and monitoring • Guidelines on use of automation • Mode awareness/understanding • Automation complacency • Redundancy and automation failure detection • Intervention • Need for active monitoring • Techniques for improving monitoring • Detection of failure • Factors affecting vigilance

10. MONITORING

CASAPNG will conduct oversight of operator compliance. This will be achieved through audits of the operator's procedures and verifications of its implementation.

11. ICAO MATERIALS

More detailed Human Factors information for specific aviation industry can be found from the ICAO Documents and Circulars (Digests) listed below:

- ICAO Doc 9859 – Safety Management Manual (SMM)
- ICAO Doc 9683 - Human Factors Training Manual
- ICAO Doc 9758 - Human Factors Guidelines for Air Traffic Management (ATM) Systems
- ICAO Doc 9806 - Human Factors Guidelines for Safety Audits Manual
- ICAO Doc 9808 - Human Factors in Civil Aviation Security Operations
- ICAO Doc 9824 - Human Factors Guidelines for Aircraft Maintenance Manual
- ICAO Human Factors Digests:
  - No. 1 - Fundamental Human Factors concepts (ICAO Circular 216-AN/131)
  - UKCAA CAP 720 - Flight crew training: Cockpit resource management and line-oriented flight training (previously ICAO digest No.2)
  - No. 3 - Training of operational personnel in human factors (ICAO Circular 227-AN/136)
  - No. 5 - Operational implications of automation in advanced technology flight decks (ICAO Circular 234-AN/142)
  - No. 6 – Ergonomics (ICAO Circular 238-AN/143)
  - No. 7 - Investigation of human factors in accidents and incidents (ICAO Circular 240-AN/144)
  - No. 8 - Human factors in air traffic control (ICAO Circular 241-AN/145)
  - No. 10 - Human factors, management and organization (ICAO Circular 247-AN/148)
  - No. 11 - Human factors in CNS/ATM systems (ICAO Circular 249-AN/149)
  - UKCAA CAP 718 - Human factors in aircraft maintenance and inspection (previously ICAO digest No.12)
  - No. 15 - Human factors in cabin safety (ICAO Circular 300-AN/173)
  - No. 16 - Cross-cultural factors in aviation safety (ICAO Circular 302-AN/175)

12. REFERENCES USED

- ICAO Doc 9859 – Safety Management Manual
- General Authority of Civil Aviation (GACA) AC 000-03 – Human Factors Principles in Civil Aviation
- European Human Factors Advisory Group – 2012 European Strategy for Human Factors in Aviation (First issue, 01 Sep 2012)
- Federal Aviation Administration (FAA) AC 120-72A – Maintenance Human Factors Training
- UK CAA Civil Aviation Publication (CAP) 715 - An Introduction to Aircraft Maintenance Engineering Human Factors for JAR 66
- ICAO Circular 240-AN/144 Human Factors Digest No7 - Investigation of Human Factors in Accidents and Incidents
- Transport Canada - Human Performance Factors for Elementary Work and Servicing TC14175
- http://aviationknowledge.wikidot.com/aviation:shell-model
- http://wikiofscience.wikidot.com/technology:shell-model-of-human-factors
- https://www.skybrary.aero/index.php/The_Human_Factors_%22Dirty_Dozen%22#cite_ref-2