Human Performance and Limitations in Aviation

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Part 1

Human Factors: Basic Concepts

Chapter 1; Human Factors

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. So the study of Human Factors is about understanding human behavior and performance.

Human Factors is the all aspects of human performance which interact with their aviation environment and the physiological or psychological aspects of human capability.

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. Human factor is the main and most important point of CRM content in Aviation. When accidents and incidents were evaluated human factor has been cited as the causal factor in the majority of accidents. It is generally accepted that greater than 80% of accidents have human error as a major factor.

Because of that reason in recent years Crew Resource Management (CRM) has become mandatory for Civil aircraft operations worldwide. In this way CRM enhance the communication and management skills of the flight crew members concerned by the effective utilization of all available resources to achieve a safe and efficient operation by reducing human error.

1.2. SCHELL MODEL :

It is helpful to use a model to aid in the understanding of Human Factors, as this allows a gradual approach to comprehension. One practical diagram to illustrate this conceptual model uses blocks to represent different components of Human Factors.

Live ware people

Hardware a/c equipments

Software a/c books and operational procedures

Environment temp . humidity . noise ….

Culture Organizational Culture

In this model the match or mismatch of the blocks (interface) is just as important as the characteristics of the blocks themselves.

A mismatch can be a source of human error. The model can then be built up one block at a time, with a pictorial impression being given of the need for matching the components.

1.2.1. Live ware :

In the center of the model is a person, the most critical as well as most flexible component in the system. Some of the more important characteristics are the following:

• Physical size and shape,

• Fatigue,

• Feeding habits,

• Health,

• Physically and mentally limitations includes stress.

1.2.2. Live ware -Hardware

This interface is the one most commonly considered when speaking of human to machine systems (ergonomics), i.e.

For example; Work space in the flight deck is very limited. In the cabin the galleys and aisles may be restricted. The user may never be aware of an L-H deficiency, even where it finally leads to disaster; this is because although the natural human characteristic of adapting to L-H mis-matches will mask such a deficiency, they will not remove its existence.

1.2.3. Live ware – Software:

This encompasses humans and the non-physical aspects of the system such as:

1- Document design i.e. briefing cards, emergency checklist layout (held in one hand/flip over etc)

2- Symbology and computer programs. Standardization of symbols and colors for lights and warnings such as Red for emergency and Green for go.

3- Procedures i.e. SOP’s, normal, abnormal or emergency, drills for pilots and cabin crew.

4- Training manuals i.e. content and design

5- Rules and regulations i.e. company and relevant aviation authority

Liveware-software problems are conspicuous in accident reports, but they are often difficult to observe and are consequently more difficult to resolve (for example, misinterpretation of checklists or symobology , non-compliance with procedures, etc.).

1.2.4. Live ware – Environment:

The human environment interface was one of the earliest recognized in flying. Initially, the measures taken all aimed at adapting the human to the environment. Later, the trend was to reverse this process by adapting the environment to match the human requirements (pressurization, air conditioning systems, soundproofing).

1.2.5. Liveware – Liveware:

This is the interface between people. Training and proficiency testing has traditionally been done on an individual basis. If each individual team member was proficient then it was assumed that the team consisting of these individuals would also be proficient and effective.

This is not always the case however and for many years attention has increasingly turned to the breakdown of teamwork.

Flight crews, Air Traffic Controllers, Maintenance technicians and other operational personnel function as groups and group influences play a role in determining behavior with performance.

In this interface, we are concerned with:

• Leadership,

• Cooperation,

• Team Work,

• Inter personal Relationships,

• Culture,

• Company Operation pressures.

1.3. SWISS CHEESE MODEL

The Swiss cheese model of accident causation is a model used in risk analysis and risk management, including aviation safety, engineering, healthcare and emergency service organizations.

The Swiss Cheese model of accident causation, originally proposed by James Reason, likens human system defences to a series of slices of randomly-holed Swiss Cheese arranged vertically and parallel to each other with gaps in-between each slice.

Most accidents can be traced to one or more of four levels of failure:

- Organizational influences,
- Unsafe supervision,
- Preconditions for unsafe acts, and
- The unsafe acts themselves.

Part 2 : HUMAN ERROR

Errors are the result of actions that fail to generate the intended outcomes. Actions by human operators can fail to achieve their goal in two different ways:

-The actions can go as planned, but the plan can be inadequate,

-The plan can be satisfactory, but the performance can still be deficient.

When accidents and incidents were evaluated , the human factor has been cited as the causal factor in the majority of accidents. It is generally accepted that greater than 80% of accidents have human error as a major factor.

Because of that reason all cases shall be investigate one by one ,error should be inhibited before it occurs and necessary precautions should be taken after investigating the error’s reasons and frequencies.

2.4.1 Human Error Types:

Human Errors can be divided in two categories :

Category 1 –Flight Crew intends to carry out an action, the action is appropriate but carries it out incorrectly, and the desired goal is not achieved. So an execution failure has occurred. Execution errors are called Slips and Lapses.

2.4.2. Slips:

Relate to observable actions and are commonly associated with attentional or perceptual failures.

2.4.3. Lapses :

Are generally involve failures of memory. Lapse is a slight error typically due to forgetfulness or inattention.

In the case of slips and lapses, the person's intentions were correct, but the execution of the action was done incorrectly, or not done at all .When the appropriate action is carried out incorrectly, the error is classified as a slip. When the action is not appropriate or not carried out, the error is termed a lapse.

Category 2 – Flight crew intends to carry out an action, does so correctly but the action is inappropriate, and the desired goal is not achieved – So a planning failure has occurred.

2.4.4. Mistakes:

Mistakes may be defined as deficiencies or failures in the judgmental and/or failure to selection of an objective or in the specification of the means to achieve it.

Mistakes are errors in choosing an objective or specifying a method of achieving it

2.4.5. Violations :

sometimes appear to be human errors, but they differ from slips, lapses and mistakes because they are deliberate 'illegal' actions, i.e. somebody did something knowing it to be against the rules (e.g. deliberately failing to follow proper procedures).

A pilot may consider that a violation is well-intentioned, e.g. electing not to climb in response to a TCAS RA, if he is certain that the other aircraft has already initiated avoiding action. There is great debate about whether flight crew should follow SOPs slavishly, or should elect to diverge from SOPs from time to time.

It is a fact of life that violations occur in aviation operations.

There are three types of violations:

• Routine violations;

• Situational violations;

• Optimising violations.

Routine violations are things which have become ‘the normal way of doing something’ within the person’s work group (e.g. flight crew from one company base).

They can become routine for a number of reasons: flight crew may believe that procedures may be over prescriptive and violate them to simplify a task (cutting corners), to save time and effort. This rarely happens in flight operations, since flying tasks are so proceduralised, but it is not unusual to see these type of violations in maintenance engineering.

Situational violations occur due to the particular factors that exist at the time, such as time pressure, high workload, unworkable procedures, poorly designed man machine interface in the cockpit. These occur often when, in order to get the job done, pilots consider that a procedure cannot be followed.

Optimising violations involve breaking the rules for ‘kicks’. These are often quite unrelated to the actual task. The person just uses the opportunity to satisfy a personal need. Flying an illegal circuit over a friend's house might be an example.

Time pressure and high workload increase the likelihood of all types of violations occurring. People weigh up the perceived risks against the perceived benefits, unfortunately the actual risks can be much higher.

2.4.6 Operator-Induced Errors:

In aviation, emphasis is often placed upon the error(s) of the front line operators, who may include flight crew, air traffic controllers and aircraft maintenance engineers.

However, errors may have been made before an aircraft ever leaves the ground, by aircraft designers. This may mean that, even if an aircraft is maintained and flown as it is designed to be, a flaw in its original design may lead to operational safety being compromised. Alternatively, flawed procedures put in place by airline, maintenance organization or air traffic control management may also lead to operational problems.

It is common to find when investigating an incident or accident that more than one error has been made and often by more than one person. The ‘error chain’ captures this concept. It may be that, only when a certain combination of errors arise and error ‘defences’ breached (see the ‘Swiss Cheese Model’) will safety be compromised.

2.4.7 Variable and Constant Errors:

A-Variable errors

B-Constant errors.

Variable errors are random in nature, whereas the constant errors follow some kind of consistent and systematic pattern.

The implication is that constant errors may be predicted and therefore controlled, whereas variable errors cannot be predicted and are much harder to deal with. If we know enough about the nature of the task, the environment it is performed in, the mechanisms governing performance, and the nature of the individual, we have a greater chance of predicting an error.

However, it is rare to have enough information to permit accurate predictions; we can generally only predict along the lines of “fatigued pilots are more likely to make errors than alert pilots”.

2.4.8 Reversible and Irreversible Errors:

Another way of categorizing errors is to determine whether they are reversible or irreversible. The former can be recovered from, whereas the latter typically cannot be. For example, if a pilot miscalculates the fuel he should carry, he may have to divert to a closer airfield, but if he accidentally dumps his fuel, he may not have many options open to him.

A well designed system or procedure should mean that errors made by flight crew are reversible. Thus, if a flight crew member incorrectly selects fuel feed which results in an imbalance, the aircraft systems should generate an appropriate alert.

2.4.9 Skill-, Rule- and Knowledge-Based Errors:

Each of these behavior types have specific errors associated with them.

Examples of skill-based errors are action slips, environmental capture and reversion.

Action slips as the name implies are the same as slips, i.e. an action not carried out as intended. The example given may consist of a pilot intending to key in FL110 into the FMS but keying in FL100 by mistake, after having been distracted by a query from his co-pilot.

Environmental capture may occur when a pilot carries out a certain task very frequently in a certain location. Thus, a pilot used to reaching for a certain switch to select function A on an Airbus A320, may inadvertently select the same switch on an Airbus 321 when, in fact, it has a different function.

Reversion can occur once a certain pattern of behavior has been established, primarily because it can be very difficult to abandon or unlearn it when it is no longer appropriate.

Thus, a pilot may accidentally carry out a procedure that he has used for years, even though it has been recently revised. This is more likely to happen when people are not concentrating or when they are in a stressful situation. Reversion to originally learned behavior is not uncommon under stress.

Rule-based behavior is generally fairly robust and this is why the use of procedures and rules is emphasised in aircraft maintenance.

However, errors here are related to the use of the wrong rule or procedure. For example, a pilot may misdiagnose a fault and thus apply the wrong SOP, thus not clearing the fault. Errors here are also sometimes due to faulty recall of procedures. For instance, not remembering the correct sequence when performing a procedure.

Errors at the knowledge-based performance level are related to incomplete or incorrect knowledge or interpreting the situation incorrectly. An example of this might be when a pilot makes an incorrect diagnosis of a situation without having a full understanding of how the aircraft systems work. Once he has made such a diagnosis, he may well look for information to confirm his (mis) understanding, while ignoring evidence to the contrary (known as confirmation bias).

2.4.10 Error Detection and Prevention;

The concept of redundancy should be applied at all stages of the aviation system, never assuming that one single mechanism, especially if human, will detect and prevent an error.

CRM provides a form of redundancy in that it emphasises the role of the second pilot to check what the first pilot has done. There is a potential danger with independent checks that the second person will trust the first person not to have done anything wrong, and therefore not to carry out the second check properly.

CRM dual checking is one of the last lines of defence, especially if no automatic system checks and alerts are present, and pilots should always be alert for the possibility that their colleague may have made an error, when carrying running through SOPs which require challenge-response checks, no matter how much they might trust and respect the other pilot. Similarly, the pilot carrying out the first action should never become complacent and rely upon the other pilot detecting an error. (The same applies with pilot-ATC communications, and read backs).

It is essential to remember that we are all human therefore we all make mistakes from time to time, so assume the worst.

Interpersonal skills are regarded as communications and a range of behavioral activities associated with teamwork.

Part 3

Basic Aviation Physiology and Health Maintenance

The Basics of Flight Physiology

The normal working of the human body when in flight can be influenced by altitude, pressure, temperature, acceleration and changes in perception.

3.1 atmosphere

The atmosphere (atmos = vapor) is the gaseous envelope of air that surrounds the earth and extends to about 25,000 miles (40,000 km). It rotates with the Earth and is continuously changing with temperature and pressure.

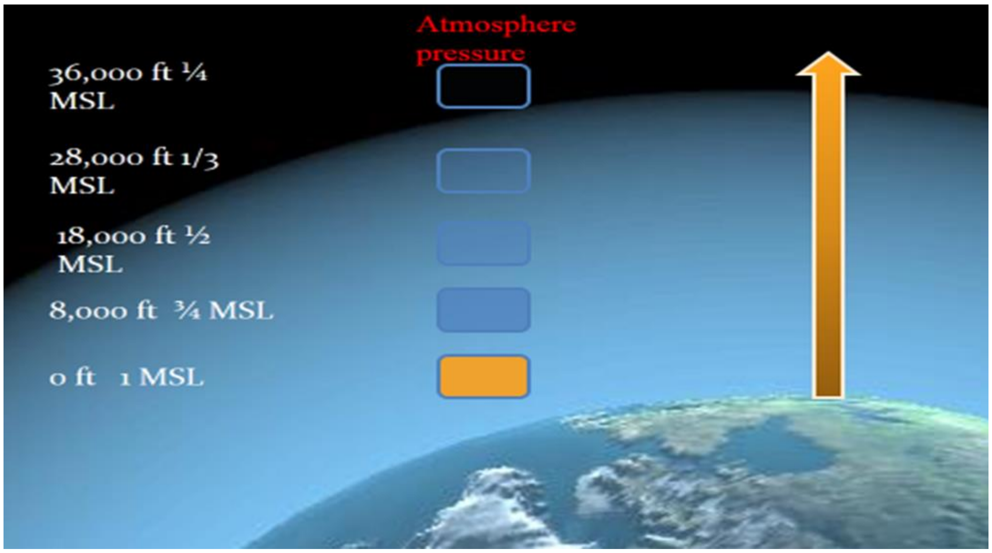
There will be constant parameters and many variables, often occurring in unpredictable situations. From a biological and physiological point of view, however, the composition of the atmosphere is constant.

3.2 The atmosphere Composition

The atmosphere surrounds the earth and forms an elastic layer of air consisting of a number of concentric shells. The inner shell is the troposphere which extends to an altitude of 30,000 ft at the poles and 60,000 ft at the equator. The atmospheric air is composed of a mixture of gases and water vapour. The most abundant gases are nitrogen (78%) and oxygen (21%), with the remaining 1% being argon, carbon dioxide, neon, hydrogen and ozone. These proportions are constant up to the tropopause (approximately 36,000 ft). In addition, the atmosphere contains solid particles such as dust and sea salt. These are important in the development of certain types of weather such as clouds, mist and fog because moisture condenses on these particles.

The pressure at sea level in the standard atmosphere is 760 millimetres of mercury (mmHg) (29.92 inches Hg, or 1013.2 millibars) and this falls to half at 18,000 ft, where the ambient temperature is about minus 208C. Knowing the percentages of the main gases present in the atmosphere, it is possible to calculate the gas pressure, in mmHg, given the atmospheric pressure at an altitude.

Figure 2.1 illustrates the reduction of atmospheric pressure with increasing altitude.



3.3 Functions of the Atmosphere

Source of oxygen and carbon dioxide

Shield against cosmic and solar radiation

Protective layer that consumes debris from space

Source of rain

Maintains the temperature and climate that sustain life on earth

Atmospheric Pressure

Atmospheric (barometric) pressure is the combined weight of all the atmospheric gases, creating a force upon the surface of the earth – the cause of this force is gravity.

The pressure of a column of the atmosphere can be measured in force / unit area:

- Pounds per square inch
- Millimeters of mercury
- Inches of mercury (Hg)

3.4 The physical gas laws

Since air is a mixture of gases which exert pressure, have measurable mass and can be compressed, it is subject to certain established laws governing reaction to changes in pressure, temperature, volume and density.

Boyle's law states that

`providing the temperature is constant, the volume of a gas is inversely proportional to its pressure'.

This means that when the pressure increases, the volume decreases and conversely when the pressure decreases, the volume increases. Put another way, at a fixed temperature the pressure of the gas varies inversely with its volume. This is strictly correct only at moderate temperatures.

Boyle's law explains some of the effects of altitude on the gascontaining cavities of the human body during flight. For example as altitude increases, the gas within the middle ear, sinuses and gastro- intestinal system will expand, sometimes with painful results.

Physiologic Divisions of the Atmosphere:

Physiologic Zone

Physiologically Deficient Zone

Partial Space Equivalent Zone

Space Equivalent Zone

Charles's law states that

`the volume of a fixed mass of gas held at a constant pressure varies directly with absolute temperature'. A feature of gas expansion is that equal volumes of different gases expand by the same amount when heated to the same temperature.

So provided the pressure remains constant, each degree centigrade rise in temperature will cause the gases to expand by 1/273 of the volume they would occupy at 08C. Another way of stating Charles's law is the volume of a fixed mass of a gas at constant pressure is directly proportional to its absolute temperature.

The gas laws of Boyle and Charles can be summarised by the equation:

pv/T = constant,

where p = pressure, v = volume, T = absolute temperature.

This is known as the gas equation, or General Gas Law, and it applies even when there is a change in all three variables, pressure, volume and temperature.

Dalton's law states that

`the total pressure of the gas mixture is equal to the sum of its partial pressures'. This means that the proportion of oxygen remains 21% throughout the atmosphere, irrespective of the total atmospheric pressure at that level.

Henry's law states that

`at equilibrium the amount of gas dissolved in a liquid is proportional to the gas pressure'. This means that the amount of gas in solution varies directly with the pressure of that gas. The relevance of this in aviation is that as altitude is increased and atmospheric pressure reduces, gases such as nitrogen will come out of solution in the body tissues. At high altitude this can lead to decompression sickness.

3.5 The circulation systems

Functional anatomy

The body tissues use oxygen to release energy to maintain life. The chemical reaction between oxygen and carbohydrate produces carbon dioxide, which is carried away from the tissues by thebloodstream to be excreted by the lungs and water. The utilisation of oxygen and production of carbon dioxide by the tissues is known as metabolism, which involves oxidation of carbohydrate from food to produce energy. This is respiration and it has three phases, each of which may be affected to some degree by flight:

(1) The exchange of gases between the body and the atmosphere

(2) The carriage of gases to and from the lungs and the site of

oxidation (the tissue cells)

(3) The actual oxidation process in the cells, liberating energy.

Circulation is the term used to describe the passage of blood through the blood vessels (arteries, capillaries and veins).

The arteries have elastic walls and carry oxygenated blood from the lungs via the heart's left atrium and left ventricle to the tissues. The vessels in the tissues are the capillaries which have very thin walls to allow diffusion of oxygen into the tissue cells and carbon dioxide out of the cells into the blood. The deoxygenated blood is carried in the veins back to the lungs via the right atrium and right ventricle of the heart. The veins do not have elastic walls and the contraction of adjacent body muscles assists the flow of blood through the veins.

An adult body contains about 5.7 litres of blood. Just over half of this is plasma which is the liquid medium in which the blood cells are carried.

There are three kinds of blood cell, each with different functions. Red blood cells (erythrocytes) contain **haemoglobin** which contains iron and is the major component of the red cells.

Function of circulatory system

- Oxygen and nutrient (fuel) transport to the cells.
- Transport of metabolic waste products to organ removal sites.
- Assists in temperature regulation.

Hemoglobin (Hgb)

Primary transporter of oxygen within the blood, and during flight does not have access to adequate amounts of oxygen to attach.

Oxygen molecules are biochemically attached to the hemoglobin molecule, which is affected by the surrounding partial pressures of oxygen (and carbon dioxide), which, in turn, transfers these gases to and from the tissue cells.

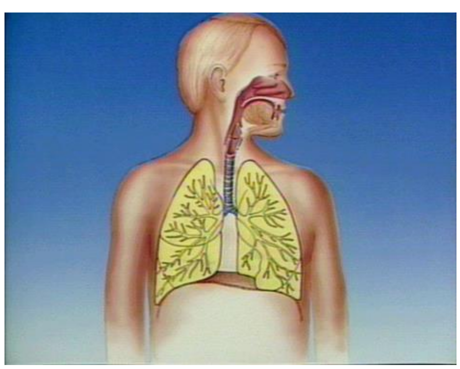
3.6 The hypobaric environment

The atmosphere is compressible and has mass. The air at the surface of the earth is supporting the mass of air above it and its molecules will therefore be pressed close together, causing the density of the air to be greatest at the surface. At sea level the partial pressure of oxygen is more than adequate to support normal living activities. With increasing altitude, there is a fall in atmospheric pressuretogether with a decrease in density and temperature. Fortunately, the relationship between the oxygen saturation of haemoglobin and oxygen tension minimises the effect of the reduction in partial pressure of oxygen. Ascent to an altitude of 10,000 ft produces a fall in the partial pressure of oxygen in the alveoli but only a slight fall in the percentage saturation of haemoglobin with oxygen. However, once altitude rises above 10,000 ft the percentage saturation of haemoglobin falls quickly and this results in the condition of **hypoxia**.

In fact, above 8,000 ft the effects of lack of oxygen will begin to appear and a decrease in an individual's ability to perform complex tasks and a reduction in night vision can be measured.

3.7 Respiratory System

The respiratory system is a group of organs and tissues that help you breathe. The main parts of this system are the airways, the lungs and linked blood vessels, and the muscles that enable breathing.



Changes in Oxygen Saturation in the Blood with Altitude Increases

Altitude (feet)	Oxygen Saturation	PaO_2
10,000	87%	60
12,500	85%	50
18,000	48%	26
25,000	9%	7
35,000	0%	0

3.8 Hypoxia

This can be defined quite simply as a lack of sufficient oxygen to meet the needs of the body tissues. Although the brain is only 2% of the body weight it uses almost 20% of the total oxygen uptake and is very susceptible to reduction in oxygen partial pressure. Thus the earliest effects of insufficient oxygen are the impairment of cerebral functions.

With an increase in altitude the air pressure decreases and above 10,000 ft there is insufficient oxygen available to maintain adequate cerebral function. There is wide variation between individuals so it is not possible to predict the exact altitude at which physical and mental impairment may occur. Another difficulty is that because of the very nature of hypoxia, the pilot becomes the poorest judge of when he or she is suffering from its insidious effects.

3.8.1 Susceptibility to hypoxia

The following factors increase an individual's susceptibility to hypoxia in flight:

. Altitude ± the greater the altitude, the more rapid the onset

. **Time** ± the longer the time of exposure, the greater the effect

. Exercise ± exercise increases the demand for oxygen

. Illness ± illness similarly increases the energy demands of the body

. Fatigue ± fatigue lowers the threshold for hypoxia symptoms

. Drugs/alcohol ± alcohol and drugs can depress brain function, thus reducing the tolerance of altitude

. Smoking ± smoking produces carbon monoxide which binds to haemoglobin with a greater affinity than oxygen, thus reducing the amount of haemoglobin available for oxygen transport.

3.8.2 Symptoms of hypoxia

A common early symptom of hypoxia is a personality change in which the normal inhibitory forces of common sense tend to be diminished, not unlike the intoxicating effect of alcohol. This progresses to impaired thinking and judgement, slowing reactions, mental and muscular incoordination, diminished vision and hearing, and impairment of memory. Eventually, there is loss of consciousness and ultimately, death.

The symptoms are insidious at first and slow to develop, but progressive and more marked at altitudes above 10,000 ft. In all cases night vision is impaired from approximately 5,000 ft upwards.

3.8.3 Stages of hypoxia

All individuals who normally live around sea level will eventually show the general symptoms of hypoxia if exposed to altitude in excess of 10,000 ft, the time of useful consciousness (TUC) being shown in the following Figure.

The stages of hypoxia can be classified by performance decrement, which is dependent upon altitude and the resulting oxygen saturation of the blood.

Indifferent stage

Occurs when breathing air at altitude of 0 to 10,000 ft, giving arterial oxygen saturation of 98 to 87%. Darkadaptation is adversely affected at altitudes as low as 5,000 ft, where visual sensitivity at night is reduced by approximately 10%. Performance of new tasks may be impaired, and a slight increase in heart and breathing rates occurs.

Compensatory stage

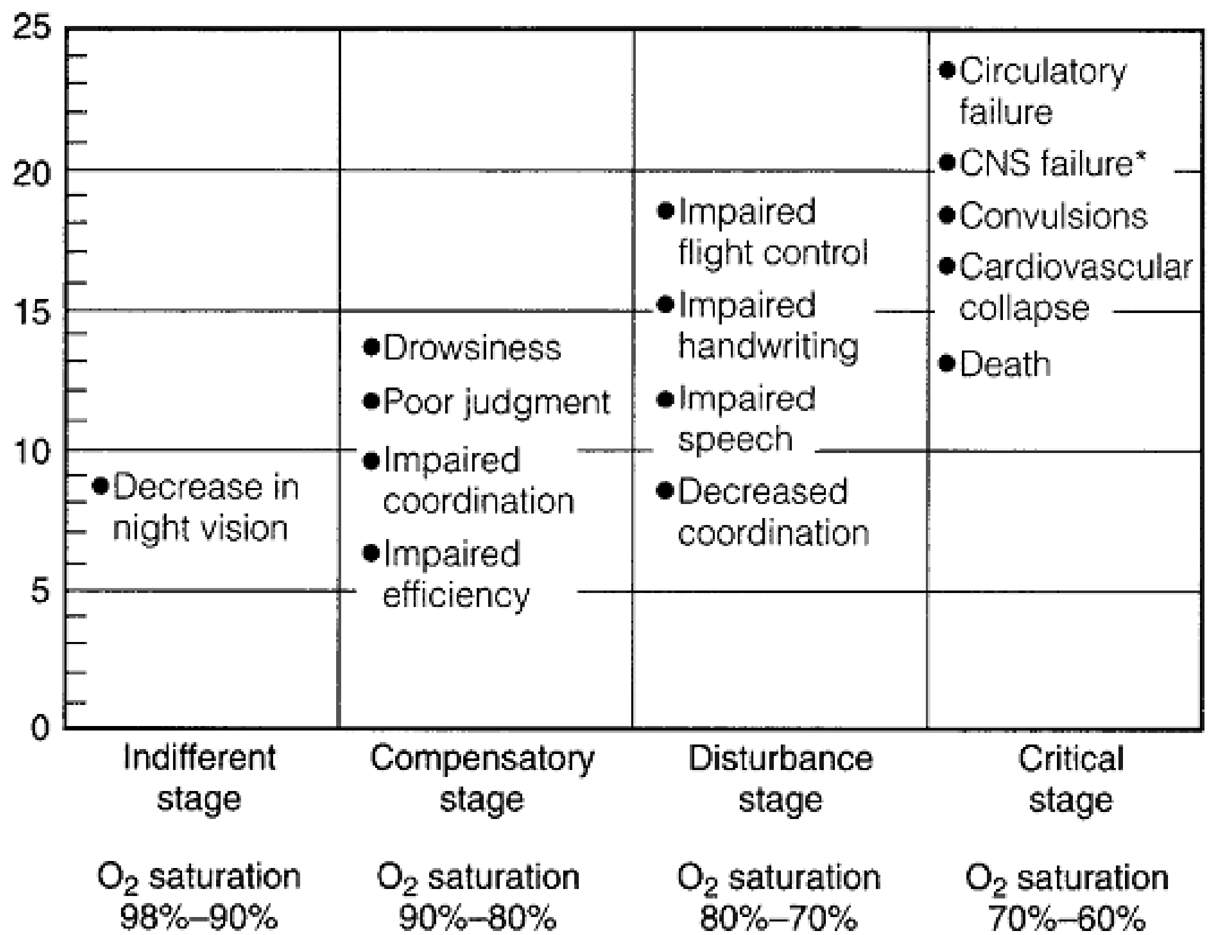
Occurs when breathing air at altitude of 10,000 to 15,000 ft, giving arterial oxygen saturation of 87 to 80%. Cardiovascular and respiratory physiological responses provide some protection against hypoxia. Effects on the central nervous system become perceptible after a short period of time. These include drowsiness, decreased judgement and memory, and difficulty performing tasks requiring mental alertness or discrete motor movements. Short term memory loss can be detected from about 12,000 ft.

Disturbance stage

Occurs when breathing air at altitude of 15,000 to 20,000 ft, giving arterial oxygen saturation of 80 to 65%. Normal physiological mechanisms no longer offer protection against hypoxia. Effects include headache, dizziness, somnolence, air hunger, euphoria and fatigue.

Critical stage

Occurs when breathing air at altitude of 20,000 to 23,000 ft, giving an arterial oxygen saturation of 65 to 60%. Mental performance deteriorates and confusion or dizziness occurs within a Critical stage.



Altitude	Time of Useful Consciousness
45,000 feet MSL	9 to 15 seconds
40,000 feet MSL	15 to 20 seconds
35,000 feet MSL	30 to 60 seconds
30,000 feet MSL	1 to 2 minutes
28,000 feet MSL	2 1/2 to 3 minutes
25,000 feet MSL	3 to 5 minutes
22,000 feet MSL	5 to 10 minutes
20,000 feet MSL	30 minutes or more

3.9 Cabin pressurisation

For prolonged flight above 10,000 ft, the use of supplemental oxygenvia a mask is both tiring and inefficient. An alternative method of maintaining an adequate partial pressure of oxygen is to pressurise the aircraft cabin to ensure the cabin altitude remains below 10,000 ft, irrespective of the actual altitude of the aircraft.

The cabin air supply is provided by tapping bleed air from the aircraft engine or by using an independent compressor, and the pressure within the cabin is controlled by an outflow valve. Maintaining the cabin at sea level pressure would require an extremely strong (and thus heavy) fuselage structure which would adversely affect weight and hence fuel economy.

We have seen that normal healthy individuals can tolerate altitudes of up to 10,000 ft with no harmful effects. However, in the case of the elderly or individuals suffering from diseases of the respiratory or circulatory system, they are less able to tolerate the mild hypoxia at this altitude. Accordingly pressurised cabins are designed to maintain an altitude in the region of 6,000 ft which gives an effective compromise between the physiological needs of the crew member or passenger and the economy needs of the aircraft operator.

3.10 Rapid decompression

If cabin pressure is suddenly lost during flight, pressure inside the aircraft will be forcefully equalised with outside air, with the cabin air being rapidly expelled. The magnitude and rate of this decompression, and the physiological effect on the occupants, will be determined by:

. the size of the cabin rupture or number of lost windows

. the altitude of the aircraft

. the amount of pressure differential between the cabin and the external environment

. the volume of the cabin

. the position of the rupture or lost window ± the venturi effect ± can lead to a further increase in cabin altitude if cabin air is sucked out.

3.10.1 Decompression sickness

In addition to the gases trapped in the body cavities, a considerable volume (primarily nitrogen) exists elsewhere within the body, not in its normal gaseous state but in solution. As altitude increases this gas comes out of solution as bubbles and these can produce discomfort or pain around the joints or muscles ± `the bends'.

Similar bubbles can form in the lung tissue, recognisable by a burning sensation or a stabbing pain in the chest, a cough and some difficulty in breathing ± a condition known as `the chokes'.

Bubbles affecting the nervous system can lead to difficulty in muscular co-ordination and this gives rise to the condition known as `the staggers'.

Finally bubbles can form in the skin and this gives an itching sensation known as `the creeps', or formication.

Decompression sickness seldom occurs below 25,000 ft and hardly ever below 18,000 ft, but this will vary with the individual and it is essential to descend to lower altitudes whenever the condition is suspected.

3.10.2 Prevention and treatment

Decompression sickness can be prevented by pre-breathing 100% oxygen before flight in order to `wash out' nitrogen dissolved in body tissues. The length of time for pre-breathing depends upon the planned flight altitude.

There is a risk of developing decompression sickness if flying within 12 or 24 hours of SCUBA diving, depending on the depth of the dive (see Chapter 4, section 4.5).

In the event of a rapid decompression at altitude, following the donning of masks and establishment of a supply of 100% oxygen, a rapid descent to below 25,000 ft and a slower descent to below 18,000 ft should prevent the development of decompression sickness. Symptoms of decompression sickness in flight should be treated with 100% oxygen and the individual should be kept warm and still.

Emergency post-flight treatment in a recompression chamber may be necessary on landing, and medical advice should be sought as soon as possible, preferably by radio communication prior to landing.

3.11 Hyperventilation

Hyperventilation may be defined as breathing in excess of the metabolic needs of the body. One of the waste products of metabolism is carbon dioxide which is carried to the lungs in the bloodstream. The rate of breathing is controlled by the respiratory centre of the brain and this reacts to the amount of carbon dioxide in the bloodstream. For example, during physical activity the body cells use more oxygen and therefore more carbon dioxide is produced.

This causes the respiratory centre to produce a faster rate of breathing. However, if a faster rate of breathing takes place without an increase in physical exertion, extra oxygen is not required so extra carbon dioxide is not produced. The excessive breathing removes carbon dioxide from the bloodstream faster than it is produced by metabolism leading to chemical changes within the blood. This is hyperventilation.

3.11.1. Causes of hyperventilation include:

. anxiety

. stress

. excitement

. motion sickness

. vibration

. heat

. acceleration (`G' forces)

. pressure breathing

. hypoxia.

3.11.2. The symptoms associated with hyperventilation are:

. dizziness

. increased sensation of body heat

. tingling sensation in the fingers and toes

. increased heart rate

. nausea

. blurred vision.

In extreme cases, loss of consciousness can occur but when this happens the breathing rate slows and respiration becomes normal again and there is rapid recovery.

The symptoms of hyperventilation are similar to those of hypoxia and it is important to be aware of how hyperventilation can be caused and the precautions to avoid it. Re-breathing air exhaled into a paper bag will slow the breathing rate and stop hyperventilation, by restoring the normal acid-base balance (inhaling carbon dioxide increases blood acidity, which decreases the breathing rate). It can be avoided by understanding the signs and symptoms and maintaining a normal rate of respiration.

Chapter 4

Factors Affecting Individual Performance

4.1 Emotional Climate (state):

The term ‘emotional climate’ refers to the way that people in the team feel about themselves and each other during flight operations.

Research indicates that factors which create a positive tone individually and collectively on the flight deck and among the wider operating team enhance the effectiveness of the cognitive and interpersonal skills displayed by crew members.

Factors that have been shown to affect the emotional climate in which the team operates include perceptions of safety, clarity of job and task expectations, supportive communication, participation and involvement, recognition for contribution and freedom of expression.

While the climate or tone of the operation depends to a large extent on the attitude and conduct of the Captain, every crew member should, nevertheless, be aware of the significance of a good working climate, and strive to put into practice those behaviors that are conducive to it.

4..2 Stress:

A factor which can quickly undermine the emotional climate in which the crew is operating is stress - defined as a state of highly unpleasant emotional arousal associated variously with overload, fear, anxiety, anger and hostility - all of which threaten both individual performance and teamwork.

Stress often arises as a result of a perceived gap between the demands of a situation and an individual's ability to cope with these demands.

As stress involves the processes of perception and evaluation, it impinges directly on the cognitive and interpersonal skills which form the basis of good CRM.

Both arousal and alertness are necessary to enable each individual to achieve optimum performance in CRM-related skills, but too much or too little arousal will have a significantly adverse impact on the ability of the crew to function effectively as a team.

It is therefore important for crew members not only to be aware of the symptoms of stress in themselves and others, but also to understand the

effects which stress can have on CRM, and to mitigate these effects where possible by taking measures to counter them.

4.3 Managing Stress:

In high pressure situations, stress can be relieved by establishing priorities and by delegating tasks to other members of the crew, but this technique can be successfully implemented only if an organizational culture has been established in the first instance which empowers subordinates by training them in the cognitive and interpersonal skills which will enable them to take on additional responsibility when the circumstances call for it.

In a low pressure situation, where fatigue, boredom and over-familiarity with the task are the greatest hazards, careful attention to environmental conditions such as heat, humidity noise, vibration and lighting can help to maintain alertness.

Concern of individual crew members for their own physical well-being by keeping fit and maintaining a healthy lifestyle, in so far as the demands of the job allow, will also help to ensure that they are best able to contribute to the team effort when the need arises.

4.4 Organizational Pressures and Morale:

Stress has been discussed earlier, but special mention should be given to commercial and organizational pressures, whether short term or long term, since these are often cited as being stressors, and can have an effect on morale. This topic is not specifically addressed within this document, but needs to be taken into account by CRM instructors when training, and when debriefing, and an opportunity given to the pilot undergoing training or checking to voice his/her concerns if such pressures are perceived to be a problem.

Of course the solution to such a problem is not within the remit of CRM, or of training in general, but it may be appropriate for the instructor to provide feedback to the operator of this, and any other, issue(s) which might be adversely influencing the performance of flight crew, and hence CRM.

4.5 Fatigue:

Alertness and fatigue are factors which can affect individual performance and hence, CRM. The more fatigued you are, the less able you will be to cope with stress and workload. Obviously, efforts should be made to avoid undue fatigue in the first place but if it is unavoidable, good CRM should help you recognize the signs of fatigue in yourself and others, and take appropriate measures to ensure that it is not detrimental to performance (e.g. napping, where appropriate and allowable, drinking coffee, etc.).

Fatigue is a major and sometimes complex topic within human factors, and is only referred to briefly here as one of the several factors which can affect performance.

4.6 Incapacitation:

An extreme case of performance decrement is incapacitation of one, both or all flight crew members. Pilots are trained in what to do under such circumstances but must not forget that CRM in its wider context is still, in fact more, important (e.g. CRM between the non-incapacitated pilot and cabin crew, and between flight deck and ATC). Training, whether standard LOFT exercises or CRM scenarios, should ensure that flight crew can cope with situations where partial or complete incapacitation might occur.

Conflict is inevitable. In fact, it is often beneficial if handled properly and in a constructive manner. Differences in feelings, opinions, thoughts, values, or action (actual or perceived) may lead to disagreement or dispute. Sometimes differences in personality alone can create a source of conflict.

A conflict will turn bad when a crew member is unable to cope with giving or receiving inquiry, advocacy or critique constructively. This conflict can polarize crew members to the point that the real problem or issue is not probed. Heated arguments can lead to bitter words or bad feelings and will ultimately effect performance unless the disagreement is brought into the open and resolved.

Alternatively, conflict can be transformed into a lively comparison of viewpoints that lead to deeper thinking, better problem definition, and sound solutions. Under these conditions, conflict resolution can provide a basis for mutual understanding and respect which strengthens, rather than erodes, team effectiveness.

Conflict resolution which holds the underlying question of who is right is destructive, conflict resolution which is focused on the question of what is right is constructive.

4.7 Decision Making:

Many types of decisions are made during the course of the flight. Some decisions of high quality can be made singularly by one member of the crew; other decisions are of such complexity or importance that the inputs from more than one crew member, or from an outside source, are necessary to ensure higher quality decisions.

When all information is resourced and analyzed, the likelihood is increased that crew members become aware of potential problems they otherwise would not have appreciated, thus can take steps to deal with them in a sound way. In no way does the consideration of all appropriate resources in the decision making process diminish the ultimate authority of the Captain. When decisions are made in this optimum manner based on a maximum of information, there exists a high potential for success, respect among crew members and commitment to full support in implementing the decision.

4.8 Attitudes

Definition: Attitude (noun); a frame of mind affecting one's thoughts and behavior;

Anti-Authority

Impulsive

Invulnerable

Macho

Resignation

It is recognized that the choice of responses forced you to select what could be an unsatisfactory alternative to the situation. The profile indicates your potential for each of the five hazardous thought patterns.

The situations presented were written in the third person so that you would apply your attitudes and judgments to another person's decision. Keep in mind that when you evaluated these situations your response was based upon your attitudes and your judgment of the situation. In other words, if you ever do exercise poor judgment, this profile will help you to understand your reasons.

The higher the relative number, the greater the probability of that particular hazardous thought pattern. Many accidents involve pilots who allow themselves to be influenced by one or more of the five hazardous thought patterns, and are enticed to takes chances as a result.

4.8.1 Hazardous Attitudes:

Anti-authority: "Don't tell me" This hazardous attitude is found in someone who does not like to be told what to do. They may either be resentful of having someone tell them what to do or may just disregard rules and procedures. An assertive person will question authority if warranted.

Impulsivity: "Do something quickly" Someone who does not stop and think about what they are about to do. They do not select the best alternative, they do the first thing that comes to mind.

Invulnerability: "It won't happen to me" Many people feel that accidents will happen to others but not to them. People who think this way are more likely to be risk takers beyond acceptable levels.

Macho: "I can do it" People who are always trying to prove themselves take risks to try and impress others. Both men and women are susceptible.

Resignation: "What's the use" People who have this hazardous attitude do not see themselves as making a great deal of difference in what happens to them. They attribute events to either good or bad luck; they leave actions to others. They can go along with unreasonable requests to be a "nice-guy."

4.9.Leadership

The best way of combating low morale is to exercise strong leadership, which can be applied using three keys: communication, consolation and co-operation. I strongly support this formula. Leadership is a perishable skill that we must preserve in today's world of management initiatives and business planning. We manage resources, we must lead people.

Air Commodore Peacock-Edward Inspector or Flight Safety (RAF) Flight Comment No.1, 1995

At the heart of Crew Resource Management is effective leadership. Each member of the crew must recognize that he or she has a leadership responsibility that is important to effective decision making.

No matter which position you occupy in the crew you must learn to become a leader in that position

There is a fundamental difference between leadership, which is acquired, and authority, which is assigned. An individual's position as captain does not automatically assume that he or she is an effective leader. Leadership skills are a function of learning. An optimal situation exists when leadership and authority are combined.

A first officer (or other crew member) has equal opportunity for leadership in their position. Acquired leadership skills can enhance any position, regardless of the assigned authority, as everyone has their position to fill. These leadership skills are also important when the first officer takes the "Pilot Flying" role, with the captain assuming the "Pilot Not Flying" role.

Leadership is a reciprocal process. There are behaviours that both a leader and a follower must apply to ensure effective performance. One leader's behaviour might be to provide direction for carrying out a task. The follower behaviour might be to provide feedback on performance of the task. Leader behaviours are less effective without complementary follower behaviours.

4.9.1. What makes a Leader?

A leader is a person whose ideas and actions influence the thought and the behaviour of others. This is accomplished through the use of examples, persuasion, and an understanding of the goals and desires of the group. The leader becomes a catalyst for change and a master of influence.

Leadership skills should be developed throughout a crew member's career. Leadership involves teamwork, and the quality of a leader depends on the success of the leader's relationship with the team. The quality of the team will be affected by the quality of the leader.

Leadership is needed to effectively understand and cope with a variety of situations. Personality or attitude clashes within a crew complicate the task of a leader and can have an influence on both safety and efficiency. Aircraft accident and incident investigations have demonstrated that personality differences can influence the behaviour and performance of crew members.

4.9.2.Leadership Skills

1-Regulating Information Flow

The leader must regulate, manage and direct the flow of information, ideas and suggestions within the crew members and outside sources

• Communicating flight information

• Asking for opinions, suggestions

• Giving opinions, suggestions

• Clarifying communication

• Providing feedback

• Regulating participation

2 -Directing and Coordinating Crew Activities

The leader must function as crew manager to provide orientation, coordination and direction for group performance

• Directing and coordinating crew activities

• Monitoring and assessing crew performance

• Providing planning and orientation

• Setting priorities

.3 Motivating Crew Members

The leader must maintain a positive climate to encourage good crew member relations and to invite full participation in crew activities

• Creating proper climate

• Maintain an "open" cockpit atmosphere

• Resolving/preventing angry conflict

• Maintain positive relations

• Providing non-punitive critique and feedback

Part 5

SAFETY CHAIN

A safe flight may be realized with a right duty plan and result of human factor. Each professional crewmember compose one circle of the chain.

5.1 Error Chain

The error chain is a concept that describes human error accidents as the result of a sequence of events that culminate in mishap.

• Poor Communication

• Poor Decision making

• Poor Leadership

5.2. Error Chain Elements

• Failure to Meet Targets

• Use of an Undocumented Procedure

• Departure from Standard Operating Procedures

• Violating Limitations or Minimum Operating Standards

• No One Flying the Aircraft

• No One Looking Out of the Window

• Lack of Knowledge

• Lack of Communication

• Unresolved Discrepancies

• Ambiguity

• Fixation or Preoccupation

• Confusion

5.3. Decision making

In aviation, decision making is the cognitive process of selecting a course of action from multiple alternatives. Decision making is the process of making up your mind to perform a course of action. Effective decision making refers to the ability to choose a course of action using logical and sound judgment to make decisions based on available information.

Crew decision making is a complex process that is strongly dependent on the situational awareness and the flight environment in which the decision must be made.

43% OF HUMAN FACTOR ACCIDENTS ARE BASED ON POOR DECISIONS

Decision-making generally has four components:

•Defining the problem

•Considering the options

•Selecting and implementing an option

•Reviewing the outcome.

5.3.1 Decision making is influenced by:

•**Situational Awareness** - a combination of availability of information and the ability of the decision maker to interpret the information (skills and professional knowledge)

•**Experience** - familiarity with similar, perhaps routine, situations.

•**Social** - social pressure, national and institutional culture.

•**Situational limitations -** Physiological & psychological pressures (stress, fatigue, hypoxia etc), time pressure.

Decision Making is strongly dependent on situational awareness and the alternatives available to a cockpit or cabin crew. A pilot's level of situational awareness determines the solutions that will be considered and helps guide the choice of a response. In addition, the results of selected actions can enhance perception and understanding of the situation, which can serve as feedback to alter and improve subsequent decisions. In fact, it is clear that situational awareness, decision making and action are thoroughly intertwined .See the Decision Making and Information Processing:

5.3.2. Barriers to good Decision Making

• Time limitation

• Inaccurate or Ambiguous data

• Pressure to Perform

• Rank Difference

• Procedures

• Personal Attitudes

• Negative Conditions

• Physiological Case

• Excitement

- Time Limitation

Use SOP, select the best decision using available information

- Inaccurate or Ambiguous Data

Cross-Check data

- Pressure to Perform

Evaluate the rational for making a decision

- Rank Difference

Use assertive behaviors

- Procedures

Mandatory regulations, rules and checklists

- personal Attitudes

Be aware of negative attitude traps

- Negative Conditions

Defect in aircraft systems, meteorology conditions, airport difficulties and communication insufficient

- Physiological Case

Hunger of oxygen, fatigue, hunger, insomnia, thirst, noise, hot-cold-humidity cases, darkness-light cases

5.3.3 Wrong Attitudes on Decision Making

- Habituation Collusion :when behaviors continuously repeated they will become habituation.
- Fatalism : To consign yourself to god.
- No stick at any rule : To show reaction when someone say how to do something.
- Antiauthority : "Don't tell me... "
- Impulsivity : "Do something quickly!"
- Invulnerability : "It won't happen to me..."
- Resignation : "What's the use?"

• Macho : “I know every thing, I will do everything” desire and penchant=dangerous twain.

• Lack of Initiative: To being successful as second or third man but not able to show the same performance when being a leader

• Hierarchy: seniority

• Excess Loading: To do so many works at the same time.

• Insist on the first Idea: Do not be open minded

5.3.4 How We Develop Decision Making?

• Designate the needs

• Be standard

• Training and familiarization

• Keep your professional attitude

• Install an effective communication

• Be disciplined and Cautious

• Declare your ideas as vocal

5.3.5. Collective decision making:

Studies of decision making traditionally have focused on decisions by individuals. Commercial aviation, however, is a group or team environment — not only in the cockpit but also among the cabin crew and on the ground (e.g., maintenance, operations). In aviation, the team represents a distributed cognitive system in which each member may affect the collective decision-making process. The leader takes a specific role in the process by assuming the responsibility for the collective decision on behalf of the team, regardless of the situation or event.

5.3.6 The steps of collective decision making:

•Access the same information either directly or by sharing among team members

•Build collective situational awareness and check for a common understanding

•Complete and mutually agree on goals

•Select and accept the course of action

•Execute the course of action using an approved task-sharing scheme after having planned it by defining the procedure, role and needs of each member

•Feed back results for monitoring the decision's effect

•Express any doubts and resolve them.

5.3.7.. Flight crew decision making model:

Flight crew are the professionally trained people who handle all the operations of an aircraft needed to secure a safe flight for the passengers. Their duties start when the plane is on the ground/before flight, while airborne or in-flight, and on landing and getting off the plane. To make things as safe as one would like to see, pilots and the cabin crews have to undergo certifications proving that they are mentally and physically fit. They are trained to be very effective decision makers as their actions and decisions can hamper the safety of all on board.

5.3.8. DECIDE Model:

In aviation the importance of making the correct decision in a timely manner is often paramount to safety. One Model that can help pilots and cabin crew, is to use the 'DECIDE' model. The 'DECIDE' model is closely linked with Crew Resource Management (CRM) and is familiar to many pilots. The acronym 'D.E.C.I.D.E' stands for :

D- Detect that the action necessary

E- Estimate the significance of the action

C- Choose a desirable outcome

I- Identify actions needed in order to achieve the chosen option

D- Do the necessary action to achieve change

E- Evaluate the effects of the action

Part 6

STRESS MANAGEMENT

6.1. STRESS;

Stress is the response to unfavourable environmental conditions, referred to as stressors, and describes how a body reacts to demands placed upon it. Stress applied to an airframe or power plant which exceeds the designed load factor leads to weakening or failure of the component affected. In the same way if excessive demands are placed on an individual, it is possible to exceed the individual's capacity to meet them. This results in a deterioration in the individual's ability to cope with the situation.

- Stress is the answer of our body to our life style.

- Stress is a reaction model that our body shows against to the cases create stress.

- A body without stress is dead. Stress is always with us in a measure. But if there is more stress than we can deal with, problems may occur.

- We should learn how to manage the stress and live with it.

- We should not try to destroy it.

6.2. Positive Effects of Stress

- Stress increases our survive chance in case of danger situations.

- Stress provides us to deal with difficult duties more easily.

- Stress increases our dominion feeling in our lives.

6.3. Signs and Symptoms of Stress:

Sweaty Palms

Increased Heart Rate

Trembling

Shortness of Breath

Gastrointestinal Distress

Muscle Tension

Sleep Problems

Backaches

↑ Blood Pressure

Immune System Suppression

Fatigue

Anxiety Disorders

Fear

6.4. Kinds Of Stress

-Physical (Temperature, Moisture, Noise, Airlessness)

-Psychological (Family, Professional Reasons)

-Emotional (Social Life, Emotional Cases)

-Chronic (Chronic, Living Conditions)

-Actual (Momentary, Bad Weather)

-Physiological -Physiological conditions, such as fatigue, lack of physical fitness, sleep loss, missed meals , Hunger, thirst, heat, cold, pain, sleep deprivation, accelerations & illness .

-Self imposed Stress (Drugs –Exhaustion –Alcohol –Tobacco –Hypoglycemia)

"Distress" is the most commonly referred to as type of stress having negative implications, whereas

“Eustress" is a positive form of stress. Distress is caused by high levels of stress and/or negative stressors (death of someone close, sickness, etc.)

while eustress is caused by moderate levels of "good" stressors (marriage, winning the lottery, etc.).

6.5. Phases Of Stress

• Alarm Phase

• Defiance Phase

• Fatigue Phase

6.6. To Being Aware Of Our Stress

• Perspiration of palm

• Rapid respiration

• Shaking

• Changes in attitude

• Loss of environmental vision

• Negative thinking

• Drawing back

• Impatience

• Excess loading

6.7. to Being Aware of Others Stress

• Breaks the conversation

• Speaks too much

• Gets exited very quickly, gets nervous

• Loss of environmental vision

• He does not listen, his mind is away from the subject

• Nervously looking

• Drawing back

• Sudden humor changes

• Imbalance in state of mind

• Impatience

6.8. Dealing With Stress

• Hesitate from stress

• Use the time very properly (do not delay the thing you have to do, do not delay the problems, give time to yourself when you feel that stress is loading on you)

• Develop relaxation techniques

• Make diet and exercise

• Speak with the others

• Organize them due to their level of significance

• Make self-criticism to yourself

• Use your religious believes

• Solve your problems

6.9. Passenger stresses

• Trouble being late

• Wasting too much time in traffic

• Excess baggage costs

• Carrying heavy bags

• Careless and cold dealing

• Uncomfortable seats

• Sitting in separate seats

• Fear, trouble

• Discomfort, disease

• Effects of oxygen and pressure to the body

• Fear to live emergency situations

• Fatigue, time difference

• Anger

Where is the first place that the passengers look in case of sudden vibration, noise, changes in engine noises or any sudden movement of aircraft?

6.10.Crew Stress Management:

- Avoid situations that distract you from safe flying.

- Look at yourself carefully for signs of stress before making any flight.

- Have there been any stressful events in your life that might impact the flight safety.

- If you have stressful event , postpone the flight
- Reduce your workload to reduce stress levels.
- If an emergency does occur, be calm.
- Maintain proficiency in your aircraft.
- Know and respect your own personal limits.
- Do not let little mistakes build into a big thing.
- Don’t let flying add to your stress.

Part 7
Fatigue

Fatigue in aviation is recognized as a serious safety concern. Fatigue poses a threat to the principles of CRM and induces human error. Human error is a contributing factor in 80% of all aviation accidents.

The NASA-Ames Fatigue Countermeasures Program has been conducting studies on pilot fatigue for the last 10 years. Their research can be confirmed by interviewing any pilot that has ever flown fatigued.

7.1. The Danger of Fatigue;

Pilots may be of the opinion that because they can stay awake for extended periods of time, they escape the adverse effects of fatigue.

This is not the case. Fatigue is insidious; individuals cannot readily feel the onset of fatigue. The fatigued person may not be aware of it's gradual and cumulative effects and consequently, may be unaware that their performance has become degraded.

The fatigued pilot may not easily accept an assessment of their degraded performance or be able to improve their performance despite increased effort.

Fatigued pilots are less vigilant, more willing to accept below par performance, and show signs of poor judgment. They may find it increasingly difficult to make decisions; they may have to recheck information several times as a result of an impaired memory or inability to process information. Alertness and reactions times are decreased. Irritability and mood swings easily block communication and hamper CRM principles.

One of the worst dangers of pilot fatigue is apathy. The fatigued pilot can be indifferent as to the outcome of the flight and their operational performance.

The NASA-Ames studies show that a person who goes without sleep for 18 - 20 hours experiences the same effects as if they had had two or three beers. They are euphoric, punchy, display decreased response time and motor control skills, segmented from their surroundings, impaired thinking.

7.2. Causes of Pilot Fatigue:

The main causes of pilot fatigue are

• The disturbance of circadian rhythms

• Continuous wakefulness

• Cumulative sleep loss

7.3.Circadian Rhythms;

The aviation industry maintains a schedule that is 24 hours a day, 7 days a week. Humans operate on a different schedule, a circadian rhythm, which can conflict with a crew member's required work periods.

This clash of schedules can affect pilot performance, behaviour and attitude. There are two circadian low periods where an individual will experience increased sleepiness - between 3 and 5 o'clock both a.m. And p.m. A combination of the circadian low period and fatigue could reduce pilot performance by up to 35%.

During sleep, the body's core temperature, often used as a biological marker, drops markedly. If you are forced to stay awake during the time normally allotted for sleep, the disruption of the circadian cycle produces the effects of fatigue.

The more time zones that are crossed, the longer it will take an individual to adjust. It is easier to adjust to a westbound time zone change than eastbound.

-Fatigue is a threat to aviation safety because of the impairments in alertness and performance of the crew.

- Fatigue is a direct result of prolonged or strenuous physical or mental effort, the effect of which is to deplete the body's resources at a greater rate than at which they are being replaced.

- Fatigue is an "Inability to function at one's optimum level, because physical and mental exertion exceeds existing capacity"

-"Fatigue" is defined as a state resulting in a decreased ability to maintain function or workload due to hard work and mental or physical stress or sleep loss.

7.4. Reasons Of Flight Fatigue

• Exceed working

• Biological Rhythm Changes

• Physical Environment Conditions

• Sleeplessness

• Psychological factors

7.5.Causes of Fatigue during flight

Fatigue is deep tiredness and, similar to stress, it is cumulative and can be caused by:

A lack of restful sleep.

A lack of physical or mental fitness.

e) Excessive physical or mental stress and anxiety,

d) Desychronisation of the body cycles (Jet Lag).

7.6. Effects Of Fatigue On Human Beings

•Physiological (Headache, digestion, allergy, muscle stretch)

•Mental (Forgetfulness, indecision, lethargy, inattention, fixation)

•Social (Lack of communication)

•Psychological (nervous breakdown, burnout syndrome, depression)

7.7.Fatigue Consequences during flight

Fatigue has significant physiological and performance consequences.Because it is essential that all flight crew members remain alert and contribute to flight safety by their actions, observations and communications.

7.8.Types of Fatigue:

- Physical:

Lack of Sleep

Lack of Oxygen

Physical unfitness

- Mental:

Stress

Anxiety & Depression

General Psychological State (e.g. Mood)

-Acute(Short-term Fatigue)

Short-term fatigue is easily recognized and remedied by sufficient rest. It is usually due to: a lack of sleep, hard physical or mental exertion, improper crew scheduling, a long duty period of flight , lack of food or Jet Lag.

-Chronic(Long-term fatigue)

Long-term fatigue is much more difficult to recognize and admit.It can be from a number of different causes which may include:

a lack of physical or mental fitness,

a stressful marriage coupled with problems at work,

financial worries and a high workload.

Motivational Exhaustion

Results from excessive unmanaged stress

Restorative measures are only temporary if stress continues

7.9.Risk Factors of Fatigue:

Extended work schedule.

shift work schedules.

Sleep/Work periods conflicting with the circadian rhythm.

Changing or rotating work schedules.

Unpredictable work schedules.

Lack of rest or nap periods during work.

Sleep disruption.

Poor Diet.

Environmental stressors.

Personal issues…death in the family, divorce, birth of child, financial stress.

A "second" job.

7.10.Cause of the Fatigue:

- limited sleep in the previous 48 hours
- been awake more than 19 hours during both day and night periods
- to be at a high level of alertness during a period of time (3-5 PM) associated with sleepiness.

7.11. Symptoms of Fatigue:

Increased reaction time

Fixation

decreased situational awareness

Short term memory loss

Decreased ability to concentrate on tasks

Impaired decision making or judgment skills

7.12. Fatigue management

• Balanced feeding

• Enough sleep

• Regular exercise

• Applying the techniques of stress and time management

• Developing positive viewpoint against life

7.13.Prevention of fatigue:

- Accept that fatigue is a potential problem,

- Plan sleep strategies pro-actively (plan sleep ahead of the next day's activities).

- Use exercise as part of the relaxation period and ensure you are fit,

- Avoid alcohol.

- Eat a regular and balanced diet.

- Have your emotional and psychological life under control

- Ensure cockpit comfort.

- Ensure your seat is properly adjusted

- Ensure that food and drink are available for long flights.

Dr Azad

CRM Instructor