Aerodrome
Advisory Circular

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Human Factor Principle in Aviation

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1.INTRODUCTION

1.1) Since the beginning of aviation, human error has been recognized as a major factor in accidents and incidents. Indeed, one of aviation's biggest challenges has been and will continue to be human error avoidance and control. Traditionally, human error in aviation has been closely related to operational personnel, such as pilots, controllers, mechanics, dispatchers, etc. Contemporary safety views argue for a broadened perspective which focuses on safety deficiencies in the system rather than in individual performance. Evidence provided by analysis from this perspective has allowed the identification of managerial deficiencies at the design and operating stages of the aviation system as important contributing factors to accidents and incidents.

1.2) During the early years, aviation safety efforts were directed towards improving the technology, with the main focus on operational and engineering methods for combating hazards. With admirable success, they sustained a reduced accident rate. When it became apparent that human error was capable of circumventing even the most advanced safety devices, efforts were then directed to the human element in the system. The late 70s and 80s will undoubtedly be remembered for the prevailing enthusiasm regarding aviation Human Factors. Cockpit (and then Crew) Resource Management (CRM), Line-Oriented Flight Training (LOFT), Human Factors training programmes, attitude-development programmes and similar efforts have multiplied, and a campaign to increase the awareness of the pervasiveness of human error in aviation safety has been initiated. Human error, however, continues to be at the forefront of accident statistics.

1.3) Statistics can be misleading in understanding the nature of accidents and devising prevention measures. Statistics reflect accidents as a series of cause and effect relationships grouped into discrete categories (flight crew, maintenance, weather, ATC, etc.). Errors are not registered as such but some of their effects are: controlled flight into terrain, aborted take-off overrun, etc. Statistics then provide the answers when it is too late. They fail to reveal accidents as *processes*, with multiple interacting chains, which often go back over considerable periods of time and involve many different components of the over-all system.

1.4) The investigation of major catastrophes in large-scale, high-technology systems has revealed these accidents to have been caused by a combination of many factors, whose origins could be found in the lack of Human Factors considerations during the design and operating stages of the system rather than in operational personnel error. Large-scale, high-technology systems like nuclear power generation and aviation have been called *sociotechnical systems*, in reference to the complex interactions between their human and technological components. *Management factors* and *organizational accidents* are key concepts in sociotechnical systems' safety. The terms *system accident* and *organizational accident* reflect the fact that certain inherent characteristics of sociotechnical systems, such as their complexity and the unexpected interaction of multiple failures, will inevitably produce an accident. In sociotechnical systems, remedial action based on safety findings goes beyond those who had the last opportunity to prevent the accident, i.e. the operational personnel, to include the influence of the designers and managers, as well as the structure or architecture of the system.

2.Definition of Human Factors in ICAO Manual:

Human Factors is about people: it is about people in their working and living environments and it is about their relationship with equipment, procedures and the environment. Just as importantly, it is about their relationships with other people. Human Factors involves the overall performance of human beings within the aviation system; it seeks to optimize people's performance through the systematic application of the human sciences, often integrated within the framework of system engineering. Its twin objectives can be seen as safety and efficiency. ICAO, HF Training Manual, Part 2 on Para 1.4.2.

3.Human factors principles:

Principles which apply to:

1) Aeronautical design,
2) Certification
3) Training
4) Operations and maintenance

These seek safe interface between the human and other system component to human performance.

4. FACTORS AFFECTING HUMAN PERFORMANCE

Basic concepts in human factors provided a conceptual framework for understanding how humans interface with various elements of their work environment. This Advisory Circular includes a brief discussion of some of the more common factors affecting human performance. Such factors create the operating context in which normal, healthy, qualified, experienced and well-motivated personnel commit errors (and sometimes, violations).
2. These factors are roughly grouped as follows: those essentially deriving from the individual, those affecting the individual's interactions with others, and those relating to the workplace, any of which can affect human performance in an aviation context.

5. Individual characteristics and performance

People are not equal in capability and performance. There are enormous differences in individual performance under similar operating conditions. These differences maybe seen both by comparing the individual's performance with others and by comparing the performance of individuals at different times. Some examples are given below.

5.1Anthropometry

Physical characteristics such as height and weight ,reach and strength, and visual and hearing acuity may limit performance. Fortunately, these remain relatively static overtime and individuals learn to cope with the physical makeup with which they are endowed. Furthermore, there are internationally accepted norms and standards which can be applied in work station design, in personnel selection and
during regular physical examinations.

5,2Health and performance

5,2,1Certain pathological conditions, such as gastrointestinal disorders and heart attacks, have caused sudden Air Traffic Controller /pilot incapacitation and in rare cases have contributed to accidents, and certain mild pathological conditions may go undetected, even by the person affected.

5,2,2 Physical fitness may have a direct relationship to mental performance and health. Improved fitness reduces tension and anxiety and increases self-esteem. It has favorable effects on emotions, which affect motivation, and is believed to increase resistance to fatigue. Factors that can affect fitness include diet, exercise, stress levels and the use of tobacco, alcohol or drugs.

5,3Habituation

Much of human behavior is automatic. We don't think about it because we have learned specific responses to particular situations. Some of these responses are culturally driven, for example, driving on the right or the left side of the road. Other responses are the product of habituation whereby we adapt to particular situations and after a while ,are not even aware of them, such as wearing a wedding
ring. Habituation is a useful mechanism for efficiently dealing with repetitive, day-to-day situations. However, under stress we may revert to a formerly correct behavior pattern creating a potential for error. Habituation can also cause us to ignore potentially dangerous indicators.

5.4 Detection and Perception

Investigation has demonstrated that there are quantifiable thresholds for detecting particular stimuli with our five senses and how many distinct levels of a particular
stimulus normal human beings can consistently discriminate. Even though our eyes or ears are technically capable of detecting a particular stimulus, our brains may not process the information and register perception in our mind .Several factors may diminish our ability to perceive a stimulus, such as distractions or noise, fatigue or boredom ,or workload or other stress. This difference between
detection and perception is critical in tasks requiring high vigilance.

5.5 Vigilance

. Increasingly, tasks in the aviation industry require a high degree of vigilance. For instance, the careful monitoring of evolving situations often involve computerized equipment. Vigilance is required by all operational personnel. It often involves monitoring activities, using either sight or hearing, for a particular event that is expected to occur only rarely. Unfortunately, boredom is a natural by-product of vigilance. Indeed research has consistently demonstrated marked reductions in the ability of humans to detect unwanted events, even after relatively
short periods of intense monitoring.

5.6
Stress

5.6.1 Stress affects human performance, sometimes positively and sometimes negatively. Although ubiquitous, stress is difficult to quantify. The concern here is with decreases in human performance caused by anything that affects the way we live and work. These things are called "stressors". They include such things as fatigue, time pressures, workload, personality conflicts, family problems
and substance abuse.

5.6.2 . The aviation environment is particularly rich in potential stressors. In the early days of aviation, the stressors of concern to flight crews were created by the environment (noise, vibration, temperature, humidity and acceleration forces) and were mainly physiological in nature. Today, they include such things as irregular working and resting patterns and disturbed circadian rhythms
associated with long-range, irregular or night-time flying.

5.6.3 . Individuals differ widely in their responses to stress. For example, flight in a thunderstorm area may be challenging for one individual but quite stressful for another. In some ways, the effect of a particular stressor can be predicted. Training and experience may help individuals in overcoming a particular work-related stress or such as performing a complex task under adverse conditions. Other
stressors may be reduced or eliminated through life style modification. Body rhythm disturbance

5.6,4 The most commonly recognized of the body's rhythms is the circadian, or 24-hour rhythm, which is related to the earth's rotation cycle. Body rhythm is maintained by several agents, the most powerful being light and darkness, but meals and physical and social activities also have an influence. Air traffic controllers and maintenance technicians with frequently changing shift schedules can suffer from reduced performance produced by circadian dysrhythmia.

5.7 Sleep

5.,7.1. Adults usually sleep in one long period each day and when this pattern has been established it becomes a natural rhythm of the brain, even when prolonged wakefulness is imposed. Wide differences have been found among individuals in their ability to sleep out of phase with their biological rhythms. Tolerance to sleep disturbance varies from one person to another and is mainly related to body chemistry but can also be related to emotional stress factors.

5.7.2 Insomnia defines a condition where a person has difficulty sleeping or when the quality of sleep is poor. When occurring under normal conditions and in phase with the body rhythms, it is called primary insomnia. On the other hand, insomnia may result when biological rhythms are disturbed. Both types of insomnia are of concern.

5.7,3 For operational personnel, the use of drugs such as hypnotics, sedatives (including antihistamines with a sedative effect) and tranquillizers to induce sleep is usually inappropriate,

as they have an adverse effect on performance when taken in therapeutic doses for up to 36 hours after administration. Alcohol acts as a depressant on the nervous system. It has a soporific effect, but it disturbs normal sleep patterns and causes poor quality of sleep. Caffeine in coffee, tea and various soft drinks increases alertness and normally reduces reaction times, but it is also likely to disturb sleep. Sleep fulfills a restorative function and is essential for sound mental performance.

5.7.4 Solutions for problems arising from sleep disturbance or sleep deprivation may include:

• modifying diet and recognizing the importance of regular meals;
• adopting measures in relation to light/darkness ,rest/activity schedules and social interaction;
• recognizing the adverse, long-term effects of drugs(including caffeine and alcohol);
• optimizing the sleeping environment; and
• learning coping strategies and relaxation techniques

5.8 Fatigue

5.8.1 . Fatigue may be considered to be a condition reflecting inadequate rest. It may arise from sleep disturbances or sleep deprivation, disturbed biological rhythms, Personal stress, etc. Acute fatigue is induced by long duty periods or by a series of particularly demanding tasks performed in a short period. Chronic fatigue is induced by the cumulative effects of fatigue over the longer term. Mental fatigue may result from emotional stress, even with sufficient physical rest. Like the disturbance of body rhythms, fatigue may lead to potentially unsafe situations
and a deterioration in efficiency and well-being. Hypoxia and noise may also contribute to fatigue.
5.8.2 . At present, there is no way to directly measure fatigue (such as a blood test) but the effects of fatigue can be measured. When errors committed are measured per unit of time, the error rate increases with fatigue. Regardless of the source of fatigue, it tends to delay reaction and decision making, induce loss of or inaccurate memory of recent events, cause errors in computation and create a tendency to
accept lower standards of operational performance.

5.9 Motivation

5.9.1 .Motivation reflects the difference between what a person can do and actually will do, and is what drives or induces a person to behave in a particular fashion. Clearly, different people are driven by different motivational forces. Even when selection, training and checking ensure capability to perform, it is motivation that determines whether a person will perform to the best of their ability in a given
situation.

5.9.2 . There is a relationship between expectation of reward and motivation since the level of effort that will be applied to obtain the reward will be determined by its
perceived value and probability of attainment. This effort must not, however, exceed capability. It is important for high performers to feel that they are in a better position than poor performers to be rewarded otherwise motivation

may decline. Those workers who enjoy a sense of job satisfaction tend to be better motivated than those that do not.

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5.10 Personality and attitudes

5.10 .1 . Personality traits and attitudes influence the way we conduct ourselves at home and at work. Personality traits are innate or acquired at early stages of life. They are deep-rooted characteristics that define a person, and are both stable and resistant to change. Traits such as aggression, ambition and dominance may be reflections of personality.

5.10 .2 . Accidents have been caused by inadequate performance by people who had the capacity to perform effectively and yet failed to do so. Reports from several confidential aviation reporting programmes support the view that attitudes and behavior play a significant role inflight safety. Certain unsafe behavior relates to deep rooted personality factors.

5.10.3 . The difference between personality and attitudes is relevant, because it is unrealistic to expect a change impersonality through training. The time to address personality issues is during the initial screening and selection process. On the other hand, attitudes are more susceptible to change through training.

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5.11 Interpersonal factors

So much of human endeavor fails not necessarily because of the performance of the individuals but because of weaknesses in the interface between them. How effective and efficient people are as they interact is a function of many factors, some of which are described below.

5.12 Information processing

Before a person can react to information, it must first be sensed. There is a potential for error here, because the sensory systems function only within narrow ranges. Once information is sensed, it makes its way to the brain, where it is processed, and a conclusion is drawn about the nature and meaning of the information. This interpretative activity is called perception and is a breeding ground for errors. Expectation, experience, attitude, motivation and arousal all have a definite influence on perception and are possible sources of errors. After conclusions have been formed about the meaning of the information, decision
making begins. Many factors may lead to erroneous decisions: training or past experience; emotional or commercial considerations; fatigue, medication, motivation and physical or psychological disorders. Action (or inaction)follows decision, and further potential for error ensues. Once action has been taken, a feedback mechanism starts to work. Deficiencies in this mechanism may also generate errors (e.g. an ATC clearance read-back error).

5.13 Communication

5.13 .1 . Effective communication, which includes all transfer of information, is essential for the safe operation of flight. Information may be transferred by speech, written word, symbols and displays or by non-verbal means such as gestures and body language. The quality and

effectiveness of communications determined by its intelligibility or the degree to which the intended message is understood by the receiver.

5.13 .2 . The quality of communications can be adversely Affected by:

• failures during transmission (e.g. unclear or Ambiguous messages);
• Difficulties caused by the medium of transmission(e.g. background noises or distortion);
• Failures during reception (e.g. another message expected, or message misinterpreted or disregarded);
• Conflict between the rational and emotional levels of communication (e.g. arguments);
• Physical problems related to hearing or speaking(e.g. impaired hearing or use of an oxygen mask);and
• use of English between native and non-native English speakers.

5.13.3 . Communication errors can be minimized through an appreciation of common communication problems and by reinforcing the standard of language to ensure error-free transmission and correct interpretation of messages.
.are for more information about each aircraft and reduced separation between aircraft requiring reduced delays in dealing with aircraft. This will lead to controllers having **5.14 Leadership**

A leader is a person whose ideas and actions influence the thought and the behaviour of others. Through the use of example and persuasion, and an understanding of the goals and desires of the group, the leader becomes a means of influence and change.. The optimal situation is when leadership and authority are
effectively combined. Leadership involves teamwork, and the quality of the leadership depends on the leader's relationship with the team.
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5.15 Workplace factors

30 The performance of all people working in aviation is strongly influenced by a set factors largely beyond their control, that is, the working conditions created by the environment and the employer. Some of these factors are outlined below.

5.16 Workload

Workload has to do with the amount of work expected from an individual. In aviation, workload generally implies mental effort as opposed to physical effort. If the workload generated by a task or set of tasks exceeds a person's mental capacity, performance will suffer. Generally speaking, training and experience equip us to effectively deal with increasing workloads. When overloaded, people may try to cope by skipping steps in their safe work routines, perhaps even ignoring obvious cues of unsafe conditions.

5.17 Training and evaluation

5.17.1 Education and training are presented here as two different aspects of the learning process. Education encompasses a broad base of knowledge, values, attitudes and basic skills upon which

more specific abilities can be built later. Training is a process aimed at developing specific skills, knowledge or attitudes for a job or a task. Proper and effective training cannot take place unless the
Foundations for the development of those skills, knowledge or attitudes have been laid by previous education. Skills, knowledge or attitudes gained in one
Situation can often be used in another.

5.17.2 Learning is an internal process and training is the control of this process. The success or failure of training must be determined by the changes in performance or
Behavior that the learning produces. Since learning is accomplished by the student and not by the teacher, the student must be an active rather than a passive participant. Memory is relevant to learning. Short-term memory (STM)refers to the storage of information that will be stored temporarily and soon forgotten, while long-term memory(LTM) refers to the storage of information for extended periods of time. STM is limited to a few items of information during a few seconds. Through repetition, information is transferred into LTM. While there is a very large capacity in LTM and fewer storage problems, there are certainly retrieval problems, as exemplified by the problems of witness recollections of past events.

5.17.3 A number of factors can interfere with the success of a training programme. Obvious ones include sickness, fatigue or discomfort as well as others, such as anxiety, low motivation, poor quality of instruction, an unsuitable instructor, inadequate learning techniques or inadequate communication.

5.17.4 .To be cost-effective, training is developed using a systems approach. Training needs are determined, possibly through job task analyses, leading to clear job descriptions. Training objectives can then be formulated, and criteria can be established for the selection of the trainees. Only then is course content and the method of course delivery determined.

5.18 Documentation

Inadequacies in aviation documentation can negatively impact safety by adversely affecting information processing. Documentation in this context includes the textual communications in both hard copy and electronic formats. Effective documentation will take into account the environment and operation in and for which the document will be used.

5.19 Workstation design

For design purposes, Terminal Building , Operation Building. Fire station &Other installations should be considered as a complete or integrated system, as opposed to a collection of separate subsystems. Expertise should be applied towards matching the characteristics of this system to human dimensions and characteristics with due consideration to the job to be performed.
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5.20 Visual performance and collision avoidance

A full understanding of how the visual system works helps in the determination of the optimum working environment. The characteristics and measurement of light, the perception of color and the physiology of the are relevant in this area. Also important are factors involved in the ability to detect aircraft at a distance, both in daytime and at night, and to identify objects in the presence of rain or other contamination on the windscreen.

5 .21 Conclusion:

This wide range of factors has the potential to adversely affect human performance. Although many of the examples cited relate to the work of flight
crews, no one is immune to human limitations. They pose implications for almost everyone working in aviation, including aircraft maintenance technicians, air traffic controllers, and flight dispatchers. For those working closest to flight operations, the risk that limitations on human performance may cause an accident are higher.

6. CULTURAL FACTORS IN AVIATION

6.1 Introduction:

The ICAO universal safety oversight audit programme seeks improvement in aviation safety on a global scale. Improving safety involves reducing or eliminating risks But judging what constitutes risk is a subjective process reflecting cultural perspectives. What is safe and what constitutes reflect unacceptable risk are in the eye of the beholder. To be effective, efforts to improve safety on a global scale must recognize the importance of cultural factors in shaping human performance. This may go against the grain of conventional wisdom where there remains a residual belief in some quarters that aviation should be “culture free”.

6.2 CULTURE AT THREE LEVELS

6.2.1 Three levels of culture have been differentiated for the purposes of:

a) national culture which differentiates the national characteristics and values system of particular nations;

b) professional culture which differentiates the behavior and characteristics of particular professional groups (e.g. the typical behavior of pilots vis-à-vis that of
air traffic controllers or maintenance engineers); and

c) organizational culture which differentiates the behavior and values of particular organizations.

6.2.2 All three cultural sets are important to safe flight operations. They determine how juniors will relate to their seniors, how information is shared, how personnel will react under stress, how particular technologies will be embraced and used, how authority will be acted upon, how organizations react to human errors (e.g. by blaming and sanctioning offenders or learning from experience). Culture will be a factor in how automation is applied in flight operations, how procedures (SOPs) are developed and implemented, how documentation is prepared, presented, and received, how training is developed and delivered, how crew assignments are made, relationships between airline pilots, operations and ATC, relationships with unions, etc. In other words, culture impacts on virtually every type of interpersonal transaction. In addition, cultural considerations creep into the design of technological tools. Technology may appear to be culture-neutral, but it reflects the biases of the manufacturer. Yet, there is no right and no wrong culture; they are what they are and they each possess a blend of strengths and weaknesses.

6.2.3 Our challenge is to understand how culture affects both individuals and aviation organizations and how that relationship can put safety at risk or serve to enhance it. To start this understanding, each of the three basic cultural sets is examined below.

6.3National culture

National culture represents the shared components of national heritage (i.e. norms, attitudes and values). As discussed above, some aspects of national culture have a particular influence on the management of flight operations. Individualists focus on themselves and their personal benefits while collectivists are more attuned to the needs of their groups. Collectivisms often associated with a willing acceptance of unequal status and deference to leaders. In such high power-distance relationships, there may be an unwillingness to question the decisions or actions of leaders, even when it may be appropriate to do so. Similarly, those uncomfortable with uncertainty will be reluctant to break the rules, even when the situation might warrant such action. They feel that written procedures are required for all situations. Those more comfortable with uncertainty may be more prone to violating SOPs, but may also be more effective in developing ways to cope with novel situations. Such dimensions are all a reflection of national culture.

6.4 Professional culture

Though personnel selection, education and training, and on-job experience professionals tend to adopt the value system of, and develop behavior patterns consistent with, their peers. They have to "walk and talk" like the others, so to speak. As with national culture, the probability of changing professional culture in the interests of safety is slim. Professional associations can develop a climate in which their members will be inclined to oppose or accept changes. Some notable safety measures in which professional associations have played on important role during safety and emergency operations**.**

6.5Organizational culture

6.5.1 Organizations must transcend national and professional cultures. Indeed, organizations are increasingly becoming multicultural. Individuals from different nations may be paired in the cockpit which can create the potential for misunderstandings and errors because of, for example ,the ever-present language barrier. Pilots may have different professional backgrounds and experience, such as military as opposed to civilian, or commuter operations as opposed to international air transport operations. They may also come from different organizational cultures due to corporate mergers or lay-offs.

6.5.2Generally, airlines are like "families" in which aviation personnel enjoy a sense of belonging. They commit a large proportion of their life to their work. In so doing, their behavior is influenced by the values of their organization. Issues such as whether the organization recognizes merit, promotes individual initiative, encourages risk taking, tolerates breeches of SOPs and promotes open, two-way communications signify the organization's culture is a major determinant of employee behavior. Unfortunately, too many major accident reports demonstrate that companies were clearly unaware of the powerful position held with respect to setting an organizational tone conducive to the safety of flight operations. Indeed, some anecdotal evidence would almost suggest blatant defiance of the basic tenets of safety. Nevertheless, it is at the organizational level that there is the greatest potential for creating and nourishing a safety culture .

7. HUMAN FACTORS IN AIR TRAFFIC SERVICES

7.1 INTRODUCTION

7.1.1 The provision of Air Traffic Services (ATS) requires large human-machine systems designed with the principal objective of achieving the safe, orderly and expeditious flow of air traffic. In addition to their principal aim, ATS systems have several secondary objectives, including fuel conservation, noise abatement, minimum environmental disturbance, cost effectiveness, impartiality towards all users within the rules and regulations, and the granting of

users' requests whenever possible. In such systems, humans (controllers and flight service specialists)rely on their equipment (hardware) to fulfil the functions of the system. To fully exploit the capabilities of their equipment, they must be able to effectively interface with the ATS system through software support, and more importantly, must interact with other persons within the ATC system and with the users of the system (controllers, flight service specialists and flight crews). While a safe and efficient ATC system must include appropriate technology, it must also comprise trained and knowledgeable professional air traffic controllers who can understand and
apply such technology and provide an effective air traffic service — safely.

7.1.2 Most Human Factors issues in ATC derive from fundamental human capabilities and limitations. For example, the information a controller (live ware) actually sees on a display can depend on what is displayed (hardware),how appropriate it is for the task (software), whether it is obscured by glare (environment) and what the controller is expecting to see after conversing with the pilot (live ware).As air traffic demands increase, so does the dependence on technological tools to aid the controller in such areas as conflict prediction and resolution, information transfer and memory. Achieving the expected benefits from
any technological solution requires the successful matching of the technology with natural human capabilities and limitations for interfacing with the other elements of the system(the hardware, the software, the environment and the live ware).

7.1.3 Given the continuous growth in air traffic worldwide, there has been a parallel increase in demand for air traffic services that often stretches the capabilities of ATC systems to the limits of its capacity. A traditional method
for expanding capacity has been the division of the airspace into smaller, more manageable sectors. However, increased sectorization of airspace may create so many more coordination and liaison problems as to be counter-productive. Alternative solutions are required, for example:

• replacement of manual functions by automated ones;

• automated data handling and presentation such as data link;

• automated assistance for cognitive human tasks such as problem-solving and decision making such as collision avoidance systems;

• provision of better data to controllers such as satellite communications and controller pilot data link communications;

• flexible use of airspace based on operational requirements rather than geographic boundaries, including direct routing;

• a change from short-term, tactical interventions to solve problems that arise to strategic planning of efficient traffic flows to prevent problems from arising in the first place, such as air traffic flow management.

7.1.4 Such advances are changing the working environment and the role of controllers, and thus, ATC procedures and practices. To ensure the continuing integrity of the ATC system and safe flight operations, diligence in the application of known Human Factors principles during the design, development and implementation of these changes will be required.

7.2 COMMON ISSUES AFFECTINGHUMAN PERFORMANCE IN ATC

7.2.1 The everyday performance of controllers and flight service specialists can be adversely affected by most of the factors mentioned in earlier discussion of this Circular .An elaboration on some of these in the context of air traffic services is provided as following :

7.3 The nature of ATC work

Air traffic control requires a lot of cognitive processing in the synthesis and analysis of significant amounts of information, the mastery of often complex procedures, real-time problem solving, and the listening and speaking skills necessary for effective information transfer. Specific cognitive skills required include:

• ***Perception*** for sensing and reacting to visual and aural information. An example is detecting and resolving emerging deviations from planned flight paths.

• ***Attention (or vigilance)*** sometimes for prolonged periods of intense activity, and sometimes for prolonged periods of relative inactivity.

• ***Learning*** to master the procedures, practices and peculiarities of the position as well as from day-today operational experience.

• ***Memory*** to interpret the evolving situation correctly and quickly, both short-term for dealing with a situation in real-time as well as long-term for integrating knowledge and procedures.

• ***Information processing*** to synthesize many diverse pieces of changing data about traffic, weather, aerodrome conditions, navigation aids, etc. into a coherent “picture” and to manage that picture in accordance with existing plans and procedures.

• ***Situation awareness*** to successfully integrate all the relevant information into a coherent and current picture. This includes knowledge of the present, past and pending situation, system functioning, human roles and tasks, and ATC roles, procedures and objectives. A controller’s worst nightmare is losing this “picture”, this understanding.

• ***Planning*** to integrate the time element by extrapolating from the controller’s picture to develop expected aircraft sequencing and spacing’ sin accordance with established procedures and objectives.

• ***Communicating*** (usually orally) for both the reception and correct interpretation of information as well as for sending information and instructions, often through the barriers of language and radio noise. Effective communicating also requires a
feedback mechanism to confirm understanding.

• ***Problem solving*** to resolve deviations from plans(e.g. developing conflicts) and to cope with unforeseen circumstances such as system outages or aircraft emergencies.

• ***Decision making*** for not only the timely selection of the best alternative course of action for a particular situation, but also to appreciate how that decision will affect subsequent traffic. Simply put, not only must the traffic flow safely and expeditiously, it must continue to be orderly.

• ***Motivation*** to adhere to high standards. Although controllers generally take great pride in their profession, there is little research to demonstrate the effects of job irritants, such as unsuitable procedures, inadequate equipment, or poor roistering,
on their desire and ability to do a good job.

7.4 The controller's workplace

Controllers work in a physical environment, whether it is in a control tower or an IFR control unit, that is generally benign in terms of temperature, humidity, light and noise. Generally, the controller's workstation is purpose-built incorporating all necessary communications, job aids and information displays with varying degrees of automation. Nevertheless, controllers regularly face workspace conditions which are fraught with potential for human errors (e.g. equipment malfunctions, displays that are difficult to read or interpret, workload, frequency congestion, personal discomfort).

7.5 Workload

The rapid, continued growth in air traffic on a global scale is outpacing the ability of most ATC systems to modernize and grow to handle the increasing volumes and complexity of traffic. Shortages of qualified controllers are widespread. These shortages are often exacerbated by the high attrition in ATC training systems and the difficulty of attracting people with the requisite aptitudes, due in part to low pay scales and poor working conditions in many States.

7.6 Teamwork

Much of the controller's work is performed independently; there is little collective decision making except, perhaps, in an emergency. Nevertheless, there is an increasing awareness of the need for teamwork in ATC ,particularly for teams of one to four individuals able to blend their skills with others in the group to provide mutual support and assistance when needed.

7.7 Judgment

7.7.1 Judgment can be considered as a sense applied to making correct decisions. In making a decision, a controller must consider all the factors which have (or
should have) an impact on the outcome of the decision. When controllers properly recognize, analyses and evaluate all the factors and subsequently make the most appropriate decision, they have demonstrated good judgment

7.7.2 Feedback is important for recognizing errors in Judgment and initiating mitigating action. Failure to recognize the error allows an increase in the potential for further errors in judgment based on the misinformation created by the initial error. However, acknowledging the initial error may depend on the attitude of the controller. Some controllers consistently demonstrate thought patterns that make such admissions of error difficult and must learn to recognize these patterns in their own behavior and correct them.

7.8 Stress

7.4.12 Air traffic control has been frequently cited as a stressful occupation because of the high task demands, time pressures and the potential consequences of errors, all of which may be exacerbated by purported equipment inadequacies and shortages of qualified controllers

7.9 Shift work

Shift work is an inevitable requirement for maintaining around-the-clock flight operations. Changing shifts has the effects on the body as trans meridian.
Studies support rotating shift patterns rather than working several consecutive nights, but shift patterns should move in the direction of a longer biological day, in
other words, to later shifts rather than earlier ones In addition to the normal physiological effects on performance, shift work can induce domestic problems
for the shift worker. Obtaining sufficient restorative sleep during the rest cycle may be difficult and family relations may suffer.

7.10 Fatigue

Controllers are subject to acute fatigue from working a particularly demanding shift, such as one with a high volume and complexity of traffic, and they may be subject to chronic fatigue due to the cumulative effects, over a long period, of excessive workloads, inadequate rest periods, inadequate restorative sleep, personal stress, etc. In any case, fatigue can adversely affect controller performance. Management has a role to play in minimizing the deleterious effects of fatigue, by arranging adequate rest breaks during each shift;

7.11 Information transfer

The ATC system may be thought of as an information management system in which nearly all information changes rapidly over short period of time. Coordinating with each other, controllers must direct and provide advisory services to pilots and airport vehicles. This is conducted almost exclusively by means of voice messages over radio telephone (R/T).The following are some of the more common human performance variables that compromise the communication process, thereby facilitating losses of aircraft separation.

a) Non-standard phraseology.

b) Call sign confusion.

c) Inadequate coordination

d) Language

e) Read back/hear back problems

f) Frequency congestion

7.12 Surveillance systems

ATC tends to be of two types: procedural separation and separation radar control with lower separation criteria based on primary or secondary radar systems. Today vast areas of the world, including most oceanic control, are covered only by procedural control. The controller has no plan view of the air traffic situation but instead relies on creating a mental picture of it by monitoring (often outdated)
flight progress strips. New satellite-based technologies are being developed and implemented which may provide the necessary up-to-date surveillance data for controllers, such as automatic dependent surveillance and controller-pilot data
link communications.

7.13 Automated equipment

The gathering, storage, compilation, integration, presentation and communication of information are essential processes in ATC, and all of them can be aided by automation. New-generation equipment provides more accurate, reliable and up-to-date data about the position of each aircraft, its plans and intentions, its flight level and speed, and its flight progress. Long-term trends less time to deal with each aircraft. Software for conflict prediction and conflict resolution is being incorporated in some of this e equipment .Successful introduction of automation depends on the approach taken at the design stage where considerable compromise is required to balance considerations such as
operational requirements, desirable features, technological feasibility and cost. Multidisciplinary teams, including end-users, engineers, human performance specialists, and so on must work together to develop and test prototypes in actual
operational conditions.

7.14 Situational awareness

7.14.1 Maintaining the mental picture is so important to controllers that a few more words about situational awareness from the perspective of the controller are warranted. Situational awareness may be considered from three levels of cognition: perceiving the situation, comprehending the significance of the situation and finally, projecting the situation into the future to make effective plans for dealing
with the situation. Some of the factors that the controller must continuously integrate to maintain a valid mental picture include:

- air traffic;
- current and forecast weather, including local effects;
- terrain, including obstacles and altitude restrictions;
- performance capabilities of different aircraft types;
- operating characteristics of particular operators;
- availability and limitations of navigation aids;
- aerodrome conditions;

• airport services available;
• ATC equipment capabilities;
• current operating procedures, restrictions, and accepted practices; and
• current capabilities of immediate colleagues and adjacent sectors.

7.14.2 Many of the changes under development or implementation in ATC with respect to automation have the potential for affecting how controllers develop and maintain their situational awareness.

7.15 SELECTION AND TRAININGOF CONTROLLERS

7.15.1 One way of reducing the scope for errors in ATC is to ensure the availability of sufficient numbers of qualified controllers, possessing all the requisite knowledge, abilities and skills for the various tasks. This requires an effective system for screening enough candidates of sufficient demonstrated aptitude and intelligence to enter ATC training, the conduct of an efficient Basic ATC training programme to keep infrequently used skills sharp or for acquiring new skills.

7.15.2 The job tasks and functions of controllers have been critically examined on a broad basis, but there is some commonality in the conclusions about the requirements for becoming a successful controller. These include general intelligence, spatial and abstract reasoning, numerical ability, memory skills, task sharing, verbal fluency and manual dexterity. Furthermore, age, medical history, eyesight, hearing, emotional stability and educational background are also relevant as selection criteria for controllers.

7.15.3 The objective of ATC training is to ensure that controllers possess the required knowledge, skills and experience to perform their duties safely and efficiently, in accordance with established standards. As for most training for complex skills, ATC training is progressive, building gradually from first principles to increasingly complex concepts. Classroom instruction is augmented by practical training, in laboratories or simulators, to develop skills in applying newly-acquired knowledge, procedures and work practices. As soon as practicable, the candidates begin on-the-job training (OJT) acquiring practical experience while working with experienced controllers indenters and towers.

7.15.4An important part of the ATC training challenge concerns upgrading controller capabilities, often to cope with equipment modernization programmers or other system changes. Here, controller retraining is required, generally incorporating both formal instruction as well as OJT.

8Working (Short-Term) Memory:

This is the memory that we use, for example, when some one gives us a phone number to call or gives us directions on how to find an office in a building

last longer by "repeating" the information to yourself "in your head"
Working memory can hold about 5 to 9 "chunks" of information. For example, you will remember the name "Steven" as one "chunk" of information, not as six separate letters.

8.1 Long-Term Memory:

Some of the information that we receive in working memory also gets stored in long-term (permanent) memory, especially if…
The same information is repeated to us several times or
If we "practice" the information (saying it over and over to ourselves)

9. Fatigue

Fatigue-A feeling of lack of energy, weariness or tiredness. Also called tiredness, weariness, exhaustion, or lethargy. Fatigue is a normal response to physical exertion, emotional stress, and lack of sleep.
Alertness-Vigilantly attentive and watchful; mentally responsive and perceptive.

9.1. Types of Fatigue:

Acute fatigue
Intense
Short duration
Cured by a good night's sleep
Chronic fatigue
Frequently fatigued
Long duration of the fatigue
Slow recovery
Often a physical sickness or mental stress that causes chronic fatigue
Not cured by one good night's sleep

10. Phobias:

Phobia = A persistent, abnormal, and irrational fear that compels avoidance, despite the understanding by the phobic person and reassurance by others that there is no danger.
Claustrophobia = Fear of enclosed spaces. A more accurate description is a fear of not having an easy escape route.
Acrophobia = Fear of heights or high levels

If a person is truly claustrophobic, they will not be able to work in an enclosed space.
If a person is truly acrophobic, they will not be able to work on top of a aircraft body or wing.
You cannot "talk" a person out of their phobia. However, phobias can be cured somewhat easily.
While true phobias are somewhat rare, some people have a rational fear of enclosed spaces or of heights. Managers need to know this when assigning tasks to airman.

11. Fitness and Health

Ill health (sickness) and poor fitness can have a negative impact on performance (work)

- Work may be of poor quality
- Errors are more likely

The purpose of awareness training is to get airman to realize when they are feeling ill or exhausted from work, and to do something about it

- Stay home if really sick
- Ask to be put on a simple task
- Ask a friend to check your work
- Take their medications

Alcohol, medication, and drugs can all have an effect on performance
Three main effects

- **Central nervous system depressant** (e.g., alcohol, pain killers, and sleeping pills) slows down your reflexes and thinking ability
- **Central nervous system stimulant** (e.g., amphetamines and caffeine) speeds up your reflexes and thinking, but too much can have a negative effect
- **Hallucinogens** (e.g., marijuana and LSD) affects your understanding of reality

Purpose of training is to get mechanics to realize that using drugs of any kind can have an affect on their performance.

- If they are on prescription or over-the-counter drugs, they need to know the side effects (e.g., drowsiness or decreased mental capacity) so that they are aware of the drug's effect on their performance and can do something about it

12. Complacency

Complacency = Self-satisfaction accompanied by unawareness of actual dangers or deficiencies
Mechanics can become complacent when they have done a task over and over again without making an error
Inspectors can become complacent when they have done an inspection many times before without finding a problem
We must fight complacency!

13.Motivation:

Motivation = Desire × Belief
Motivation = A process within a person that causes the person to move toward a goal.
Motivation is determined both by…
The desire to succeed, and
The belief that effort will result in success

Example: Someone who does not believe they can win a race will not try hard no matter how badly they want the prize.

14 .erformance = Skill × Motivation

Performance is determined by BOTH:
Skill
&
Motivation

15 Increasing Desire to Succeed

Desire to succeed at your job is not increased by:
Salary
Doing the same routine work day after day
Desire to succeed is increased by:
Fringe benefits
Incentive pay
Task complexity
Degree of job flexibility
It is a manager's job to increase an employee's desire to succeed (motivate) at their job

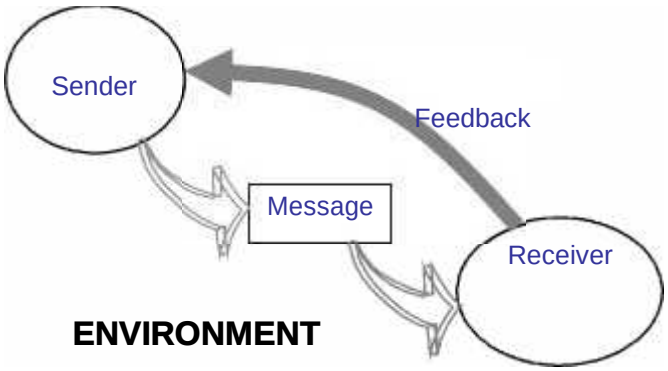
16 **Effective Team Behaviors**:

Communication
Assertiveness
Situation Awareness
Leadership

a. Communication:

17. Communication - The ability to clearly and accurately send and acknowledge information and to provide useful feedback.

Basic Communications Model:



17.1 Barriers to Effective Communication:

Passive listening
No feedback
Poor feedback
Not using the right words
Inappropriate method
Vague or late information

17.2Overcoming Barriers to Communication:

- Use active listening
- Request feedback
- Use appropriate emphasis (loudness)
- Use common words

17.3 Written Communication:

- Written communication can be hard
  - No visual feedback to tell you if the reader understands
  - The reader cannot ask questions
- Make sure that your writing is:
  - Correct
  - Complete
  - Clear
- Use computer spell checker

17.4 Shift/Task Handover:

- Best shift/task handover would include…
  - A written handover logbook entry about the task, including
    - What was completed
    - Exactly where in the task the handover occurred/where the task is to be started
    - Needed tools/parts/material to continue the work
    - Any special requirements (e.g., waiting for an inspection)
    - Any work done that was outside the task card (e.g., loosened a clamp)
  - A verbal handover with the mechanic taking over the task
  - A task card that was completely filled out (all "worked by" and "checked by" signatures completed) up to where the mechanic quit working on the task

17,.5 Cultural Differences in Communication:

- Some of these beliefs deal with communication issues
  - Do not admit to mistakes
  - Indirect (not straightforward) communications
  - Pilots will not talk to maintenance staff, etc.
- Discuss how the participants' national/ organizational cultures affect communication

17.6 Assertiveness:

- Providing relevant information without being asked

Making suggestions
Asking questions as necessary
Confronting ambiguities
Willingness to make decisions
Maintaining position when challenged until convinced by the facts
Clearly stating positions on decisions and procedures
Refusing an unreasonable request

17.7 Situation Awareness:

Situation Awareness - The ability to maintain awareness of what is happening on the ramp or the hangar, as well as what is happening on the task.

Situation Awareness Is the Ability to:

See elements (e.g., people and equipment) in the work environment
    Where they are now
    Whether they are moving or stationary
Understand the importance of what you see, especially with regard to hazards/problems
Project the status of the elements for the near future (i.e., determine future implications) in order to detect situations requiring action

17.8 Barriers to Situation Awareness:

Insufficient communication
Fatigue/stress
Task overload/under load
"Groupthink" mindset
Degraded operating conditions

17.9 Overcoming Barriers to Situation Awareness:

Actively question/evaluate
Use assertive behavior when necessary
Analyze/monitor situation continuously

18 Leadership:

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

Direct and coordinate crew activities
Delegate tasks to crew members
Ensure crew understands expectations
Focus attention on critical aspects of situations
Keep crew informed of task/shift information
Ask crew members for relevant task/shift information
Provide feedback to crew on their performance
Create and maintain a professional atmosphere

18.1 Barriers to Effective Leadership:

Micro-management - failure to delegate
Poor interpersonal skills
Inexperience
Pressure
New situations
Rigidity

18.2 Effective Leadership:

Make suggestions; do not dictate
Encourage crew to participate
Lead by inspiration
Provide feedback to the crew

19 . HUMAN FACTORS PRINCIPLES IN AERODROME EMERGENCY PLANNING:

19.1 Aerodrome emergency planning is the process of preparing an aerodrome to cope with an emergency occurring at the aerodrome or in the vicinity. The objective of aerodrome emergency planning is to minimize the effects of an emergency, particularly in respect of saving lives and maintaining aircraft operations. The aerodrome emergency plan sets forth the procedures for coordinating the response of different aerodrome agencies and of those agencies in the surrounding community that could be assist in responding to the emergency. The Emergency plan shall observe Human Factors principles as per this Advisory Circular to ensure optimum response by all existing agencies like Airport Rescue & Fire Fighting (ARFF) personnel , ATC. Airport security . Engineers. Aircraft operators, Aerodrome Operator & other external organization participating in emergency operations.

19.2 **Types of Airport Emergency Exercise & Consideration of Human Factor:**

19.2.1 There are 3(Three) methods of testing the airport emergency plan:

a) Full scale exercises;

b) Partial exercises; and

c) Tabletop exercises.

19.2.2 These test shall be conducted on the following schedule:

Full Scale: At least once every Two years;
Partial: At least once each year that a full scale exercise is not held or As required to maintain proficiency;
Tabletop: At least once each Six months, except during that six month period When a full scale exercise is held.

19.2.3 Precautions must be taken, where necessary, human factors concepts to mitigate weather-induced physical and other problems such as hypothermia and dehydration. Such considerations apply to emergency personnel as well as to victims of the accident.

20 . Adherence to Human factor principal:

Assessment is very much a part of aviation industry practice and provides one means of meeting standards and determining competency. Decisions as to suitable and productive means of operational personnel assessment will be an important influence in human performance in working place On the other hand, skill acquisition in aviation has traditionally been achieved on the job or in the course of high-fidelity simulation. Skill assessment and associated operational techniques have traditionally been conducted in the same environment .However, notwithstanding the influence of current practice, the desire for formal assessment of Human Factors skills must always be counterbalanced by full consideration of any negative learning consequences which may arise from that very assessment.

HUMAN FACTORS CHECKLIST:
To determine the relevant areas warranting Human Factors assessment/ investigation / analysis, the importance of each factor by indicating the appropriate weighting value mentioned below will be given beside each item:

0=Not contributory
1=Possibly contributory
2=Probably contributory
3=Evidence of hazard.

1.Name of the employee:
2. Designation:
3.Working position:

4.Name of organization :
5. Name(s) of the Inspector:
6. Date & time of assessment:

BEHAVIOURAL FACTORS

A Personal problems(family, professional financial) ----------
B. Overconfidence, excessive motivation ----------
C. Lack of confidence ----------
D. Apprehension / panic ----------
E. Error in judgment ----------
F. Delay ----------
G. Complacency, lack of motivation ----------
H. Interpersonal tension ----------
I. Drug abuse ----------
J. Alcohol / hangover ----------
K. Personality, moods, character ----------
L. Memory mindset ----------
M. Habit patterns ----------
N. Perceptions or illusions ----------

MEDICAL FACTORS

A. Physical attributes conditioning & general health ----------
B. Sensory acuity(vision, hearing, smell, etc.) ----------
C. Fatigue ----------
D. Sleep deprivation ----------
E. Nutritional factors ----------
F. Drug / alcohol ingestion ----------
G. Stress ----------
H. Hypoxia ----------
I. Other acute illness (es) ----------
J. Pre-existing disease(s) ----------

OPERATIONAL FACTORS

A. Lack of currency / proficiency ----------
B. Command & control in ARFF Vehicles ----------
C. Command &control, supervision ----------
D. Ability to carryout instructions ----------
E. Working environment (noice,fatiguevisibility,etc.) ----------
F. Selection and training ----------
G. ARFF Crew capability ----------
H. Inadequate knowledge of procedures ----------
I. Limited experience ----------
J. Workload saturation ----------
K. Situational awareness ----------

EQUIPMENT DESIGN FACTORS

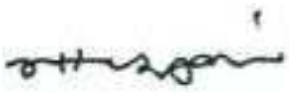
A. Design/location of instruments, controls ----------
B. Lighting ----------
C. Workspace incompatibility ----------
D. Visual restrictions due to structure ----------
E. Aerodrome design and layout ----------
F. Effects of automation ----------
G. Confusion of controls, switches, etc ----------

ENVIRONMENTAL FACTORS.

A. Weather ----------
B. Visibility restriction ----------
C. Noise ----------
D. Hot/ cold ----------
E. Windblast ----------
F. Smoke, fumes ----------
G. Oxygen contamination ----------
H. CO poisoning 0or other toxic chemicals ----------
I. Radiation ----------
J. Electrical shock ----------

INFORMATION TRANSFER FACTORS

A. Adequacy of written materials ----------
B. Misinterpretation of oral communication ----------
C. Language barrier ----------
D. Noise interference ----------
E. Disrupted oral communication ----------
F. Crew /AT S communication ----------
G. Airport signals, marking and lighting ----------
H. Ground signals ----------



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