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AERODROME ADVISORY CIRCULAR

Subject: Guidance on Application of Human Factors in ARFF, Emergency Planning and Aerodrome Maintenance Planning

1. Introduction

1.1 The para 9.1.6, 9.2.43 and 10.1.2 of Civil Aviation Requirement Section 4, Series B, Part I mandates the aerodrome operators to observe the human factors principles for Aerodrome Emergency Plan, RFF Training Programme and design & application of maintenance programme at an aerodromes in India.

1.2 This circular has been formulated to provide the guidance to the aerodrome operators regarding the human factors principles to be applied during preparation of the above documents and implementation thereto in order to ensure that concerned personnel are conversant with the application of human factors.

2. Human Factors Principles

2.1 The subject of human factors is about people. It is about people in their working and living environments. It is about their relationship with equipment, procedures and the environment. Just as importantly, it is about their relationships with other people. Human Factors involve the overall performance of human beings within the aviation system; it seeks to optimize people's performance through the systematic application of the human factors. Its twin objectives can be seen as safety & efficiency and well-being of operational personnel.

2.2 Human Factors is essentially a multidisciplinary field, including but not limited to; psychology; engineering; physiology; sociology; and anthropometry. Indeed, it is this multidisciplinary nature and the overlapping of the constituent disciplines that make a comprehensive definition of Human Factors challenging. The detailed guidelines are available in ICAO Doc 9683 on the subject of Human Factors Training Manual.

3. The SHELL Model

3.1 The SHELL model provides a conceptual framework to help understand Human Factors. It illustrates the various constituents and the interfaces - or points of interaction - which comprise the subject. Human Factors elements can be divided into four basic conceptual categories:

- a) Software: plans, procedures, documentation etc.
- b) Hardware: machine, equipment, etc.
- c) Environment: internal (e.g. workplace), external (e.g. surroundings) etc.
- d) Liveware: the human factor

3.2 Interactions between people and the other elements of the SHEL model are at the heart of Human Factors, which involves the interfaces between:

- a) People and machines - "Liveware vs. Hardware"
- b) People and procedures - "Liveware vs. Software"
- c) People and colleagues - "Liveware vs. Liveware"
- d) People and workplace - "Liveware vs. Environment"



S = Software (procedures, symbology, etc)
 H = Hardware (machine);
 E = Environment
 L = Liveware (human);

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.

4. Human Factors Issues in ARFF Services

4.1 A competent and professional ARFF service must rely on a comprehensive and relevant set of training modules, coupled with an internal audit framework to regularly check the effectiveness and efficacy of these programmes. However, in the process of promulgating the training framework, one must not be overly fixated with the 'hard' skills component of the training outcomes. Thought must be given to the 'soft' human factor components during the promulgation and execution of the training programmes. Similarly, any assessment of the operational effectiveness of ARFF personnel must take into account human factor principles to work as a team.

4.2 As the success of any ARFF operations rely very much on teamwork, the importance of building mutual trust and team coordination amongst staff during training cannot be overstressed (Liveware vs. Liveware). Training must therefore be designed to guide ARFF personnel towards achieving these objectives.

4.3 In order for ARFF training to be as realistic as possible, live fire training is crucial in helping ARFF personnel acclimatize to a heat and smoke filled environment (Liveware vs. Environment), so that in the event of an actual emergency, ARFF personnel will be able to execute their tasks more confidently and effectively. Where possible, simulators replicating different facades of ARFF operations (e.g. vehicle driving and operations; command and control etc.) should be made available for ARFF personnel to be trained in a controlled, safe and realistic environment.

4.4 ARFF operations require firefighting personnel to be proficient in the operation of fire vehicles and other rescue equipment (Liveware vs. Hardware). This is crucial as it would enable the ARFF service to control any aircraft fires swiftly and effectively, in order to facilitate the evacuation and rescue of survivors. The airport fire vehicle is therefore an extremely vital asset that must be designed to take into account the human instinct and intuition of the vehicle operator. Therefore, ARFF services must place sufficient emphasis on the design ergonomics of fire vehicles during the pre-fabrication stage in order to optimise human performance during training and operations.

4.5 The design of fire stations is another important factor that could affect the human performance of ARFF personnel when responding to aircraft accidents or incidents (Liveware vs. Environment). This is especially relevant for large aerodromes which provide a high category of fire protection. Fire stations in such aerodromes are typically larger, thus requiring ARFF personnel to travel a longer distance before reaching their fire vehicles. Such considerations must therefore be taken into account during the design phase of a fire station so that the ARFF service is able to meet the stipulated response time in the event of an aircraft emergency.

4.6 Communication is possibly the most important human factor in ARFF operations. Operational readiness and safety standards will be compromised without effective communication amongst ARFF personnel, air traffic control and pilots. Therefore, the type of communications equipment and the transmission of messages must allow critical information to be conveyed, assimilated, processed and executed (Liveware vs. Hardware and Liveware vs. Liveware). Therefore, ARFF training programmes must incorporate components to ensure the accurate and timely transmission of information to avoid miscommunication which could result in serious consequences.

4.7 It is obvious that any ARFF service will need to be kept up-to-date with the constant development and innovation of more sophisticated rescue equipment and fire vehicles (Liveware vs. Hardware). It is equally important for ARFF personnel to be well acquainted with the different configurations of various aircraft types operating at the particular aerodrome. Boosting the knowledge of ARFF personnel in these areas would indirectly enhance human performance during a response to any aircraft emergency.

4.8 The ARFF industry is a highly specialised one which compels the management and leadership team of ARFF services to promulgate a system of self-audit. Such systems must not only include the ratings and revalidation of individual standards. More importantly, as we recognise the importance of teamwork and team coordination in ARFF operations, ARFF services should place heavy emphasis on the collective performance of an ARFF outfit during such an audit (Liveware vs.

Liveware). The audit can then reveal observations and findings about the effects of human behaviour on pre-stipulated procedures. Similarly, such audits can also highlight human reaction to any unforeseen circumstances in the form of injects during a unit proficiency test. Results from the audits can then be used to modify, tweak and improve training programmes in order to enhance human performance during ARFF operations.

4.9 In the aftermath of an aircraft accident, it is often necessary to provide CARE (Caring Action in Response to Emergency) treatment for the survivors. However, aerodrome operators and ARFF services must also not neglect the mental and psychological well-being of emergency responders such as ARFF personnel who may suffer from post-traumatic stress disorders. It will therefore be essential to provide CARE treatment for ARFF personnel after a major crisis (Liveware vs. Liveware) both from a welfare perspective and also from a business continuity standpoint. Such treatment and counselling can be provided by other ARFF or airport personnel who had undergone the proper training or more likely to be provided by external medical institutions. Arrangements for the latter should then be formalised in the form of mutual aid agreements or can be incorporated into the aerodrome emergency plan (Liveware vs. Software).

4.10 The job nature of ARFF personnel poses numerous potential hazards (Liveware vs. Environment). The risk of inhalation of carbon or smoke particles when extinguishing a fire, either during an incident or during training, is very high. Therefore, ARFF services must provide all fire fighters with the appropriate personal protective equipment (PPE) such as self-containing breathing apparatus (SCBA), helmets, boots, protective clothing etc. In relation to day-to-day operations, the uniform worn by ARFF personnel should also be of a suitable material depending on the local climate and conditions.

4.11 To ensure that ARFF personnel are able to perform their roles effectively, thought needs to be put into designing an appropriate physical fitness programme to condition them for the physical rigours of the job (Liveware vs. Environment). In the process of designing any physical fitness programmes, due considerations must be given to individual human limitations. ARFF management must also accept that not all personnel can perform at the same level of physical fitness standard. The key is to establish the minimum physical fitness requirements of a fire fighter and design a programme that can best replicate these demands.

4.12 Noise is an important human factor (Liveware vs. Environment) that is omnipresent in an airport environment and cannot be ignored. Most fire stations are located within close proximity of the runway and aircraft movement areas, thus exposing ARFF personnel to constant loud noises. Besides posing as disruptive interferences during the transmission of messages, long term and regular exposure to noise can have serious implications on one's health (e.g. temporary, partial or permanent hearing loss). To address this issue, ARFF services should issue and mandate the use of suitable hearing protection devices. In addition, personnel who are subjected to constant exposure to noise should be sent for regular noise induced deafness (NID) hearing tests.

4.13 Fatigue is one important factor that directly affects human performance and is greatly influenced by the shift system of ARFF services (Liveware vs. Software).

There must be considerations to ensure that ARFF personnel can have sufficient rest despite the need to be on 24-hour operational readiness at most airports.

4.14 A leader is an individual whose ideas and actions influence the thought and behaviour of others (Liveware vs. Liveware). Through the use of motivation and persuasion, and an understanding of the goals and desires of the team, the leader becomes an agent of change and influence. Skilled leadership may be needed to understand and handle various operational, training and administrative situations. For instance, personality clashes within a team complicate the task of a leader and can affect both safety and efficiency.

5. THE NEED FOR HUMAN FACTORS IN AERODROME EMERGENCY AND AERODROME MAINTENANCE PLANNING

5.1 The overall safety and efficiency of the civil aviation system depends on human operators as the ultimate integrators of the numerous system-elements. This dependence is unlikely to decrease, and may even increase in unanticipated ways, as additional advanced technology is implemented. To a greater extent, understanding and accounting for the role of humans, including their positive and negative contributions, will be important to maintaining and improving safety while improving efficiency.

5.2 The human sciences study the structure and nature of human beings, their capabilities and limitations, and their behaviours both singly and in groups. Human Factors uses this information based on its relevance to practical problems.

5.3 Emergency planning is the process of preparing the aerodrome to cope with an emergency occurring at the aerodrome or in its vicinity. The objective of the emergency planning is to minimize the effect of an emergency particularly in respect of saving lives and maintaining aircraft operation.

5.4 The Aerodrome Operators in developing policies, procedures and guidelines for Aerodrome Emergency and maintenance services shall take into account human factors principles as described below. This need for Human Factors is based on its impact on two broad areas, which inter relate so closely that in many cases their influences overlap and factors affecting one may also affect the other. These areas are:

5.4.1 Effectiveness of the system:

5.4.1.1 *Safety:* It illustrates the various constituents and the interfaces — or points of interaction — which comprise the subject. According to SHELL's model Human Factors elements can be divided into four basic conceptual categories:

- i. Software: documentation, procedures, symbols, etc.
- ii. Hardware: machinery, equipment, etc.
- iii. Environment: both internal and external to the workplace
- iv. Liveware: the human element.

a) Liveware-Liveware (L-L)

- i. Communication skills
- ii. Listening skills

- iii. Observation skills
- iv. Operational management skills;
- v. Leadership and followership
- vi. Problem solving
- vii. Decision-making

b) Liveware-Hardware (L-H)

- i. Scanning
- ii. Detection
- iii. Decision-making
- iv. Cockpit adjustment
- v. Instrument interpretation/situational awareness
- vi. Manual dexterity
- vii. Selection of alternative procedures
- viii. Reaction to breakdowns/failures/defects
- ix. Emergency warnings
- x. Workload; physical, allocation of tasks
- xi. Vigilance

c) Liveware-Environment (L-E)

- i. Adaptation
- ii. Observation
- iii. Situational awareness
- iv. Stress management
- v. Risk management
- vi. Prioritization and attention management
- vii. Coping/emotional control
- viii. Decision-making

d) Liveware-Software (L-S)

- i. Computer literacy
- ii. Self-discipline and procedural behaviour
- iii. Interpretation
- iv. Time management
- v. Self-motivation
- vi. Task allocation

5.4.1.2 Efficiency:

- 1) Application of group interaction principles.
- 2) The proper layout of aerodrome facilities, access points and performance of equipment including fire tenders promotes and enhances effectiveness.
- 3) Properly trained and supervised crew members are likely to perform more efficiently.
- 4) From the perspective of efficiency, standard operating procedures (SOPs), are developed to provide the most effective methods of operations, and should be regarded as a means of measuring the performance of all members involved in emergency and maintenance services.

5.4.2 *Well-being of operational personnel:*

5.4.2.1 **Fatigue.** Fatigue may be considered to be a condition reflecting inadequate rest, as well as a collection of symptoms associated with displaced or disturbed biological rhythms. Acute fatigue is induced by long duty periods or by a string of particularly demanding tasks performed in a short term.

5.4.2.2 Body rhythm disturbance. Safety, efficiency and well-being are affected by the disturbed pattern of biological rhythms typical of today's long-working hours.

5.4.2.3 **Health and performance.** Certain pathological conditions — gastrointestinal disorders, heart attacks, etc. — have caused sudden failure on human performance.

5.4.2.4 **Stress.** Stress can be found in many jobs, and the aviation environment is particularly rich in potential stressors. Of main interest is the effect of stress on performance. In the early days of aviation, stressors were created by the environment: noise, vibration, temperature, humidity, acceleration forces, etc., and were mainly physiological in nature. Today, some of these have been replaced by new sources of stress: irregular working and resting patterns and life events.

6. The above guidelines are minimum in nature and not exhaustive. The aerodrome operators are advised and free to adopt any additional human factors principle, which in the opinion of the operator, would enhance the efficiency and safety in execution of any plan or procedure.

Sd/-
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