Advisory Circular
[AC/AD – 14]

Human Factors Principles
in
Aerodrome Emergency Planning

Second Edition
February 2022

CIVIL AVIATION AUTHORITY OF NEPAL

RECORD OF AMENDMENTS

Amend. No	Chapter Changed	Pages Replaced	Signature	Date

REVISION HISTORY

Edition No	Date	Chapter/ Section	Details
01	May 2013	All	Advisory Circular: Human Factor Principles in Aerodrome Emergency Planning
02	February 2022	All	Advisory Circular: Human Factor Principles in Aerodrome Emergency Planning

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FOREWORD

Nepal as a Contracting State to the Convention on International Civil Aviation has an obligation to the international community to ensure that civil aviation activities under its jurisdiction are carried out in strict compliance with the Standards and Recommended Practices contained in the nineteen Annexes to the Convention on International Civil Aviation to maintain the required aviation standards.

Safety of the civil aviation system is the major objective of the international Civil aviation organization and Civil Aviation Authority Nepal. It has long been known that some three out of four accidents result from less than optimum human performance, indicating that any advance in this field can be expected to have a significant impact on the improvement of flight safety. Human performance is cited as a casual factor in the majority of aircraft accidents. If the future accidents are to be prevented, Human Factors issues in aviation must be better understood and Human Factors knowledge more broadly and proactively applied. By proactive it is meant that Human Factors knowledge should be applied and integrated during the systems design, planning and implementation. The human performance in aerodrome emergency is of utmost importance as a lot of action in emergency situation is taken by human judgment.

Users of this Advisory Circular are requested that the provisions of the ***Civil Aviation Authority Act - 1996 (2053 B.S.), CAAN Airport Certificate Regulations - 2004 (First Amendment - 2016) and Civil Aviation Regulation 2002, (Third Amendment 2017)*** rather than this Advisory Circular, determine the requirements of, and the obligations imposed by or under, the civil aviation legislation. Users should refer to the applicable provisions when any doubt arises.

This advisory circular is a digest for Human factors principles in Aerodrome Emergency Planning, specially ARFF managers and personals. As per Civil Aviation Requirement for Aerodrome (CAR – 14, Part 1), section 9.1.6 the Aerodrome emergency planning shall observe Human Factors principles to ensure optimum response by all existing agencies participating in emergency operations. CAR 14 part 1 recommends the guidance material on Human Factor principles as Human Factors Training Manual (Doc 9683) but the manual (Doc 9683) is neither entirely applicable nor intimately relevant to ARFF services, instead focusing more on human performance and team coordination pertaining to flight operations. This report addresses those short-comings and studies the operational effectiveness, safety and wellbeing of the ARFF services and Human Factors principles and philosophy in Aerodrome Emergency Planning.

This Authority may, without any prior notice, change the content of this Advisory Circular as appropriate.

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Director General

Civil Aviation Authority of Nepal

Babar Mahal, Kathmandu, Nepal February 2022

LIST OF ACRONYMS AND ABBREVIATIONS

ARFF	Airport Rescue and Firefighting
CNS/ATM	Communications, Navigation and Surveillance Systems for Air Traffic Management
CAAN	Civil Aviation Authority of Nepal
CAR	Civil Aviation Requirements
Doc	Document
ICAO	International Civil Aviation Organization
NID	Noise Induced Deafness
PPE	Personal Protective Equipment
RFFS	Rescue and Firefighting Services
SCBA	Self-Containing Breathing Apparatus
SHEL	Software, Hardware, Environment, Liveware
USOAP	Universal Safety Oversight Audit Programme

1 Purpose

The purpose of this Advisory Circular is to provide guidance to aerodrome operators on its Airport emergency plan where knowledge of human factor principles is part of competency requirement in the training of aerodrome rescue and fire- fighting (ARFF) personnel.

2 Introduction

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 sciences, often integrated within the framework of system engineering. Its twin objectives can be seen as safety and efficiency.

2.2 Human Factors is essentially a multidisciplinary field, including but not limited to; psychology; engineering; physiology; sociology; and anthropology. Indeed, it is this multidisciplinary nature and the overlapping of the constituent disciplines that make a comprehensive definition of Human Factors difficult.

3 The SHELL Model

3.1 The SHEL 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

1.2 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"

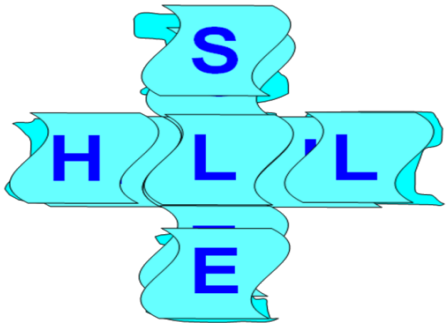

Figure 1 The SHEL model as modified by Hawkin
S= Software (procedures symbology, etc)
H= Hardware (machine);
E= Environment
L= Liveware (human);
In this model the match or mismatch of the blocks (interface) is just as important as the characteristics of the blocks themselves. A mismatch can be a source 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 such as team coordination.

4.2 Human factors principles are not only confined to the development of ARFF training programmes. Consideration must also be given to the formulation of drawer plans such as the aerodrome emergency plan and the unit tactical plans of the ARFF service.

4.3 The application of human factor principles to ARFF services can therefore be classified into two broad pillars as follows:

a) Operational effectiveness and standards; and

b) Safety and well-being of ARFF personnel

5 Operational Effectiveness and Standards

5.1 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.

5.2 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.

5.3 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.

5.4 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 runway 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.

5.5 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.

5.6 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 anyaircraft emergency.

5.7 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.

6 Safety and Well-Being of ARFF Personnel

6.1 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).

6.2 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.

6.3 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.

6.4 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.

6.5 Fatigue is one important factor that directly affects human performance and is greatly influenced by the shift system of ARFF services (Liveware vs. Software). Besides the need to conform to local labour rules and regulations of individual States, 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.

6.6 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.

7 Conclusion

7.1 Human factors specific to ARFF services pervade a wide spectrum of activities, ranging from training and operations to station routine and audits. The study of human factors principles can be described as both an art and a science and must be associated with the entire range of ARFF activities in order to achieve a higher level of professionalism, a higher state of operational effectiveness and a higher standard for safety.

8 References

Civil Aviation Requirement for Aerodrome (CAR – 14, Part 1);

CAAN SMS Requirements, 2010;

ICAO Doc 9859 - Safety Management Manual;

ICAO Doc 9137 - Airport Services Manual, Part 1; and

ICAO Doc 9683 - Human Factors Training Manual.

9 Queries

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