AC 139-7-5 (Rev 0)
1 March 2023

Civil Aviation Authority of Singapore

Advisory Circular

PROTECTION AGAINST CHEMICAL AGENTS DURING ARFF

GENERAL
Advisory Circulars (ACs) are issued by the Director-General of Civil Aviation (DGCA) from time to time to provide practical guidance or certainty in respect of the statutory requirements for aviation safety. ACs contain information about standards, practices and procedures acceptable to CAAS. An AC may be used, in accordance with section 11 of the Air Navigation Act 1966 (ANA), to demonstrate compliance with a statutory requirement. The revision number of the AC is indicated in parenthesis in the suffix of the AC number.

PURPOSE
This AC provides the guidance to demonstrate compliance with, and information related to the initial intervention on incidents involving chemical agents within the aerodrome before the arrival of the hazmat (hazardous materials) response teams.

APPLICABILITY
This AC is applicable to an operator who intends to or holds an aerodrome certificate or heliport certificate.

RELATED REGULATIONS
This AC relates specifically to Regulation 36 of the Air Navigation (139 – Aerodromes) Regulations 2023 (“ANR-139”).

RELATED ADVISORY CIRCULARS
AC 139-7-3 Guidance on emergency planning

CANCELLATION
This is the first AC issued on the subject.

EFFECTIVE DATE
This AC is effective from 1 March 2023.

OTHER REFERENCES
- Congressional Research Service

- WHO Guidance on Public Health Response to Biological and Chemical Weapons
- Singapore Civil Defence Force (SCDF) – Community Emergency Preparedness Programme (CEPP)

1 INTRODUCTION

1.1 Regulation 36 of ANR-139 requires rescue and firefighting equipment and services to be provided at an aerodrome. The Aerodrome Rescue and Fire Fighting (ARFF) services would be the first responders should there be an incident involving chemical agents within the aerodrome. Understanding the characteristics of these agents and equipped with the appropriate detectors, the ARFF services would be able to provide initial intervention before the arrival of the hazmat (hazardous materials) response teams.

1.2 Threats involving CBRE (Chemical, Biological, Radiological and Explosives) agents are nothing new in the current world. Emergency services should therefore be equipped with basic knowledge on such threats.

1.3 Terrorists' use of chemical agents is widely believed to be an event that has low probability, but potentially high consequences. An example would be the Sarin gas attacks on the Tokyo subway in 1995.

1.4 Chemical agents are chemicals posing exceptional lethal threats and danger to humans. Depending on the type of agent used, they cause a variety of symptoms in victims. Some cause death by interfering with the nervous system. Some inhibit breathing and lead to asphyxiation. Others have caustic effects on contact. As a result, chemical attack treatment may be complicated by the need to identify at least the type of chemical used. Furthermore, chemical agents trapped on the body or clothes of victims may place first responders and medical professionals at risk.

1.5 Protection from and detection of chemical agents is, thus, an area of much concern for first responders. Depending on what chemical is encountered, different protective equipment must be employed. For example, a gas mask alone is not sufficient protection against chemicals which can damage through skin contact.

2 TYPES OF CHEMICAL AGENTS

2.1 Chemical agents, which include chemical weapons and some toxic industrial chemicals, are normally organized into four groups:

(a) Nerve agents;
(b) Blister agents;
(c) Blood agents; and
(d) Choking agents.

2.2 The above chemical agents are categorized by the effects they cause to those exposed to them. Nerve and blister agents are predominantly only manufactured and used by militaries as weapons, while both blood and choking agents include chemicals widely used in industrial processes.

2.3 Nerve agents

2.3.1 Chemical agents affecting the nervous system are called nerve agents. These agents do not occur naturally, but are man-made compounds, and are mainly liquid in nature. Examples of these agents are Sarin, Soman and VX.

2.3.2 Nerve agents are extremely dangerous and can enter the body through the lungs or by skin contact. They interfere with the nervous system, causing over-stimulation of muscles. Victims may suffer from nausea, weakness, and possibly spasms and convulsions. When exposed to high concentrations, loss of muscle control, nervous system irregularities, or death may occur. These reactions can be irreversible if victims are not treated quickly.

2.3.3 The treatment window for nerve agent exposure depends on the type of agent. Some agents react quickly and irreversibly to enzymes within the body, while others require a much longer time to permanently bind to these enzymes. The most effective treatment occurs before such permanent binding takes place.

2.4 Blister agents

2.4.1 Blister agents, also known as vesicants, are chemicals that cause painful blistering of the skin. While such blistering is not generally lethal, the excruciating pain caused by blister agents requires full body protection against these chemicals. The most common blister agent is mustard agents, which includes nitrogen-based and sulphur-based compounds. Mustard agents are oily liquids which range in colour from very pale yellow to dark brown, depending on the type and purity, and have a faint odour of mustard, onion or garlic. These liquids evaporate quickly, and their vapours are also injurious. Blister agents are not naturally occurring compounds.

2.4.2 Blister agents can enter the body through the lungs or by contact with the skin or eyes. Some can penetrate through normal clothing material, causing burns in areas that were covered by cloth. The initial symptoms of blister agent exposure are reddening of the skin resembling sunburn, combined with pain in the affected area. Swelling, blisters, and lesions may then develop depending on the degree of exposure. Systemic symptoms such as malaise, vomiting, and fever may also develop in extreme cases.

2.4.3 The eyes are also very sensitive to blister agents. At high vapour exposures, great pain, corneal damage, and scarring between the iris and lens may occur. The most severe eye damage is often caused by liquid agent, either from contact with airborne droplets or by self-contamination of the eyes from contaminated clothing or body parts. Victims inhaling blister agents may suffer damage to their lungs. While a single, low-level exposure will likely produce only temporary impairment, high concentrations or repeated exposures may cause permanent damage. Inhalation victims may have symptoms ranging from mild bronchitis to blistering of the lungs.

2.4.4 Damage from blister agent exposure, lesions and other skin irritations, are treated according to the different type of symptoms developed. Hospitalization may be required for respiratory tract injuries. Victims who suffer severe lung damage may require mechanical ventilation.

2.5 Blood agents

2.5.1 Blood agents are chemicals that interfere with oxygen utilization at the cellular level. Hydrogen cyanide and cyanide salts are agents in this group. Hydrogen cyanide is a very volatile gas, smelling of almonds, while cyanide salts are odourless solids.

2.5.2 Blood agents act through inhalation or ingestion and impair cellular oxygen use. The central nervous system is especially susceptible to this effect, and blood agents usually cause death through oxygen starvation of brain cells. The symptoms of blood agent exposure depend upon the agent concentration and the duration of exposure. In mild cases, there may be headache, dizziness, and nausea for several hours, followed by complete spontaneous recovery. Higher concentrations or longer exposure may additionally cause convulsions and coma. Very high concentrations may lead to powerful gasping for breath, violent convulsions, and cardiac failure within a few minutes.

2.5.3 The effects of blood agents are reversed through treatment with specific antidotes. When symptoms such as convulsion or depressed breathing are present, ventilation with oxygen and administration of anticonvulsants are used.

2.6 Choking agents

2.6.1 Chemicals that act on the lungs, causing difficulty in breathing and, potentially, permanent lung damage are known as choking agents. Examples of choking agents include chlorine, ammonia and phosgene. These agents are generally gases that have marked odours and may colour the surrounding air.

2.6.2 Choking agents injure victims through inhalation, with a comparatively mild effect on the skin. Exposure to low chemical concentrations causes chest discomfort or shortness of breath, irritation of nose and throat, and tearing of the eyes. At higher concentrations may quickly cause swelling of the lungs, respiratory failure, and possibly death. Symptoms of lung damage can occur up to 48 hours after inhalation of moderate concentrations, and often do not manifest themselves until the lungs are aggravated by physical effort.

2.6.3 Victims of choking agents are generally treated according to the different type of symptoms developed. Since lung damage may be exacerbated by exercise, victims are kept at rest until the danger of fluid in the lungs is past. Symptoms such as tightness of the chest and coughing are treated with immediate rest and comfort. Shallow breathing and insufficient oxygen may require supplemental oxygen.

3 PROTECTION AGAINST CHEMICAL AGENTS

3.1 Physical protection against chemical agents includes gas masks and special protective clothing. Gas mask filters equipped with chemical filters are effective against inhaled chemical agents. For those chemical weapons that cause effect upon skin contact, a protective garment is required. These garments range in complexity and protective ability. Hazmat suits are typically suits made of layered rubber with activated charcoal. The rubber in protective equipment is impermeable to most chemical agents, while the activated charcoal acts in a manner similar to a gas mask filter. The combination of mask and suit provides full protection against most chemical exposures.

3.2 Decontamination, where chemicals are removed from the victims, usually through washing the eyes and skin with water and a dilute bleach solution (against some chemical agents), is an essential protection against secondary chemical exposure. In addition to stopping victim's exposure to the chemical agent, this procedure prevents those treating the victim from becoming victims themselves, and thus avoiding contamination of treatment facilities. Decontamination is especially important in those cases where victims have encountered liquid chemical agents, and may have significant amounts of chemical agent trapped in their garments. In events with gaseous chemical agents, decontamination may be less critical. Treatment of the victims will begin after decontamination is completed.

4 DETECTION OF CHEMICAL AGENTS

4.1 Detection of chemical agents can serve many purposes. One is to provide warning of a chemical attack, allowing additional time to react to a terror event. Another is to identify the chemical agent used in an attack. This might provide for better treatment and more effective response. Finally, determining when an area is clear of chemical agents after a terror attack requires sensitive post-event detection.

4.2 Handheld detectors, such as the Chemical Agent Monitor (CAM), are able to detect some chemical agents, namely nerve and blister agents, at levels that are below the lethal threshold, but above the acceptable daily exposure limit for civilians. This equipment is recommended for first responders at the scene. Automatic sampling devices, such as the Automatic Chemical Agent Detector/Alarm (ACADA), can also be employed to provide automated, constant atmospheric sampling.

5 CONCLUSION

5.1 Aerodrome rescue and firefighting (ARFF) services, being the first responder, should be equipped with basic knowledge on the potential threats posed by these agents. With the appropriate protection and detection, they will be able to identify the type of chemical agent present and take appropriate steps to evacuate victims around the affected area before the arrival of the hazmat response teams, thus preventing the incident from escalating.