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INTERNATIONAL RESEARCH IN SOCIAL, HUMANITIES AND ADMINISTRATIVE SCIENCES



EDITOR
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AIRCRAFT RESCUE & FIRE FIGHTING (ARFF) PERSONNEL TRAINING STANDARDS WITH THE SCOPE OF HIGH REACH EXTENDABLE TURRET (HRET) SYSTEM USED IN AIRCRAFT FIRE

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1. INTRODUCTION

Airplanes are the main unit of air transport. While providing this service, airplanes need airports where they can land/take off safely. Various safety measures are taken for aircraft at airports. Various teams are established to ensure these safety measures. One of them is fire crews.

Fire crews established at airports are formed in accordance with various standards. Airport fire crew personnel are specially trained for aircraft fires. Personnel working in airport fire teams in our country receive fire training at the Civil Defense and Fire Fighting Department of Universities, then they receive ARFF (Aircraft Rescue and Fire Fighting) training by the General Directorate of State Airports Authority (DHMI, 2016).

Fire crews may encounter various aircraft fires and accident-destruction. The most intense of these is the emergency situation experienced as a result of a bird hitting the engine (propeller) section. Although we encounter engine fire more often in airplanes, another fire area that we should pay attention to is the inside of the fuselage of the airplanes. Established fire teams are equipped with specially manufactured vehicles. These vehicles have various features that are not found in other fire vehicles. There are three types of vehicles in firefighters. These; Airport Fire Response Vehicle, Accident Crime Rescue Vehicle and Instant Response Vehicle. The most important fire tool is the Airport Fire Response Vehicle. It is an extremely effective tool in aircraft fires with its features. This vehicle has a

system specially designed to fight in-body fires. The name of this system is the High Reach Extendable Turret (USA Air Force Research Laboratory, 2011).

2. AIRPORT FIRE CATEGORIES AND NUMBER OF FIRE VEHICLES

When establishing airports, a fire team is formed at their central points. The reason why the airport fire teams are set up at the central point is to reach the farthest points of the airport in a safe and effective time in case of emergency. Established fire teams are shaped according to certain standards. In these standards, it is stated that the airport fire category should be determined as the priority. The number of personnel and vehicles is determined according to the determined aerodrome category (SHGM, 2010; ICAO 9137-AN/898, 2014; NFPA 403, 2018) Table 1 below shows the square categories.

Table 1: Aerodrome Category

Aerodrome Category	Aircraft Length	Trunk Width
1	From 0 m to 9 m (excluding)	2 m
2	From 9 m to 12 m (excluding)	2 m
3	From 12 m to 18 m (excluding)	3 m
4	From 18 m to 24 m (excluding)	4 m
5	From 24 m to 28 m (excluding)	4 m
6	From 28 m to 39 m (excluding)	5 m
7	From 39 m to 49 m (excluding)	5 m
8	From 49 m to 61 m (excluding)	7 m
9	From 61 m to 76 m (excluding)	7 m
10	From 76 m to 90 m (excluding)	7 m

After the aerodrome category is determined, the number of personnel is determined. In Table 2, the minimum number of personnel required to be in the airport fire team is given.

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Table 2: Minimum number of ARFF personnel to be present at airports

Aerodrome Category	Number of Staff
1	2
2	2
3	2
4	3
5	6
6	9
7	9
8	12
9	15
10	15

After determining the number of personnel, the minimum number of fire vehicles is determined according to Table 3 below.

Table 3: Minimum number of fire vehicles determined by aerodrome category

Aerodrome Category	Number of Fire Vehicles
1	1
2	1
3	1
4	1
5	1
6	2
7	2
8	3
9	3
10	3

The number of personnel and vehicles given in Table 2 and Table 3 are the minimum numbers. This amount can be increased according to the number of runways or risk assessment. In addition, the numbers specified are the quantities that should be present in one shift. The logic of the category system is the fire load calculation of the aircraft. For this reason, the selection of categories is based on aircraft dimensions. The main thing is to determine the number of personnel and vehicles that can fight against the determined fire load.

3. FEATURES OF AIRPORT FIRE FIGHTING VEHICLES

Airport firefighting vehicles are specially designed for combating aircraft fires. So much so that the amount of fire extinguishing agents (water, foam, supplemental substances) in these vehicles is determined according to the airport aerodrome category (Airport Standards Directive 702, 2016). In Table 4 below, the minimum amount of water required in the vehicles according to the aerodrome category is given.

Table 4: Minimum amount of water required in airport firefighting vehicles

Aerodrome Category	A Level Foam	B Level Foam
	Amount of Water (liter)	Amount of Water (liter)
1	350	230
2	1000	670
3	1800	1200
4	3600	2400
5	8100	5400
6	11800	7900
7	18200	12100
8	27300	18200
9	36400	24300
10	48200	32300

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Before supplying a special fire extinguishing vehicle to the airport, we need to pay attention to the dimensions and criteria specified in the NFPA 414 Standard for Aircraft Rescue and Fire Fighting Vehicles (NFPA, 2012). The basic features of fire fighting vehicles at airports are given below:

- It should have a water tank of suitable capacity,
- It should have a foam tank of appropriate capacity,
- It should have a complementary material warehouse of appropriate capacity,
- Water and foam tanks should be made of corrosion-proof material,
- It should have a pump system with an appropriate capacity,
- The pump system must be capable of operating while the vehicle is in motion,
- There should be main water outlet points,
- Must have emergency response hoses (wrapped in drum and rubber),
- Must have bumper turret,
- Must have a roof turret,
- Must have Extended Roof Monitor (optional),
- The vehicle must have lower irrigation nozzles,
- It should have a fire protection system,
- Must have the necessary equipment and materials to be used in the fire extinguishing process,
- It should have a water and foam suction system,
- It should have an automatic or semi-automatic transfer system,
- Must have an engine with instant acceleration,
- Must have a cabin with a crew capacity of at least 4 people,
- Must have strong braking system,
- There should be a warning system against overturning,
- Must have projection lighting system,
- Must have audio broadcasting system,
- It should have warning and warning lights,

- It should have an area where portable fire extinguishers can be placed,

- Must have the ability to move in the field,

- Must have material cabinets,

- There should be filling caps in the upper parts of the water and foam tanks,

- There should be a single piece of glass with panoramic view in the front of the cabin,

- Must have a radio system.

4. HIGH REACH EXTENDABLE TURRET (HRET) SYSTEM

There are many systems and tools to be used in fire prevention and extinguishing activities at airports. Fire extinguishing systems installed in hangars and special production airport fire response vehicles in fire teams can be given as examples of these systems and vehicles. Today, developing technology has also been effective in fire vehicles used in airports. Airport fire vehicles have many features unlike conventional fire vehicles. The most important of these is the High Reach Extendable Turret (HRET) System (NFPA 402, 2019).

4.1. HRET SYSTEM ADVANTAGES AND DISADVANTAGES

High Reach Extendable Turret (HRET) System has many advantages over the conventional roof monitor. Some of these are listed below:

- More effective intervention by using less extinguishing agent,

- Range increase according to the intervention distance of the roof monitor (thanks to the extended arm),

- Accessibility without moving the vehicle with its lateral, vertical and linear movement features,

- Intervening in body fires more quickly with the possibility of external intervention,

- Enabling firefighting personnel to intervene in the fire more easily with the ventilation of the system,

- As a feature of the piercing nozzle, the possibility of intervention with fine water spray,

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- extinguishing agent effectiveness with less interaction with the wind,

- Possibility of direct intervention in the center of the fire,

- Access to all parts of the aircraft,

- More sensitive response to fire with centralized intervention,

- Possibility of opening a ventilation hole in the body of the aircraft thanks to the piercing nozzle

- Controlled response to fire with setting options such as high flow and low flow,

- Easy access to engines placed at high points,

- It has the opportunity to get more efficiency with less personnel.

High Reach Extendable Turret (HRET) System has both advantages and disadvantages. These;

- Since it is a metal structure, it can conduct electricity,

- Possibility of misuse due to lack of training in aircraft risk areas,

- Damage caused by holes to be drilled in the body as a result of incorrect determination of the fire location,

- The possibility of the system affecting the passengers as a result of the inability to effectively evacuate the passengers,

- It has disadvantages such as direct injection into fuel tanks and causing fuel leakage.

4.3. CONSIDERATIONS IN USING THE HRET SYSTEM

High Reach Extendable Turret (HRET) System is an extremely effective system in the fight against fires. For this reason, we need to know how to use it in detail and well. There are many issues that the operator should pay attention to regarding use. Before we start using the system, we need to make a good event analysis. As the system operator, we need to take into account the directives of the crew chief, and we need to implement sudden decisions according to the flow of the event. While analyzing the incident, we must definitely check the inside of the fuselage using the thermal camera. This control will provide us with the possibility of point intervention.

After the incident analysis is done, we need to check whether the evacuation process has been carried out or not. The use of the system without evacuation will adversely affect the passengers. If the evacuation has not been done yet, we can use the system to secure the evacuation area. For example; foaming can be shown to materials that have a risk of burning in the discharge area. After the evacuation process, the doors of the aircraft should be closed to prevent air entry into the fuselage. In this way, we can reduce the oxygen rate that will feed the fire. Another thing we need to pay attention to is to position the fire extinguisher appropriately according to the mobility of the High Reach Extendable Turret (HRET) System. The effective position of using the drill nozzle at the end of the system is the position where it stands parallel to the ground. We need to pay attention to this issue as much as possible. We must determine the point and angle we will drill well. The most important extinguishing agent in the fight against aircraft fires is foam. When using the High Reach Extendable Turret (HRET) System, we should definitely use foam as extinguishing agent. In some models of the system, we can also use supplementary materials. By using the complementary material with foam, we have the opportunity to obtain a more effective extinguishing agent. We can easily use the High Reach Extendable Turret (HRET) System for cooling and covering operations. Cooling or covering is done by transferring extinguishing agent to the body from outside. The operator using the system must have knowledge of aircraft construction materials and risk zones. When inappropriate response procedures are investigated, this is usually operator-related. The operator either does not know the system well or does not know the risk zones of the aircraft. In particular, risky areas such as fuel tanks and points where oxygen cylinders are located should be well known.

4.4. HRET SYSTEM TRAINING

The most important issue with the supply of a system is the correct use of the system. Good training is required to ensure this. Generally, the training of the provided vehicle is given by the company that provides it. Afterwards, a trainer training course is given to some personnel from the user institution, depending on the supply contract. After this stage, the trainings continue to be given in-house. There are many elements in the content of the High Reach Extendable Turret (HRET) System training. While creating the training content, the following points should be considered (FAA ARFF Vehicle and High Reach Extandable Turret (HRET) Operation, 2010):

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- First of all, it should be ensured that the personnel receive training on aircraft risk areas.
- Subsequently, aircraft building materials should be taught.
- High Reach Extendable Turret (HRET) System training should be arranged for each aircraft separately.
- Positioning training should be given to position the firefighting vehicle relative to the High Reach Extendable Turret (HRET) System.
- Separate training should be provided for different models of vehicles in the fire team.
- The training content should be updated every year, and the trainings should be developed depending on the use of the system. For this, incident reports should be kept in detail.
- Vehicles with High Reach Extendable Turret (HRET) System have a different center of gravity compared to normal fire extinguishers. In this regard, drivers should be given special driving training.
- All drivers, whether used as system operators or not, should be included in the training to learn the system.
- Simulator programs related to the use of the High Reach Extendable Turret (HRET) System should be provided. Simulated training has advantages over regular practical training. As an example to this; Many scenarios can be realized more cost-effectively.
- The training carried out should be renewed every 12 months, that is, once a year.
- The staff working as trainers should pay attention to the initial and refresher trainings and they should definitely be certified by the authorized institutions.

5. ARFF STAFF TRAINING STANDARDS

In order for Aircraft Rescue & Fire Fighting Personnel (ARFF) to perform their duties correctly, including in structural fires; It is necessary to successfully complete a basic education that covers many vital issues such as fire extinguishing, personal protective equipment, fresh air breathing devices, search and rescue, ventilation and first aid and requires the highest level of discipline. The ability of

the personnel in the ARFF services to perform rescue and firefighting activities correctly and effectively in the event of an aircraft emergency, which is not seen very often, depends on their lack of training. In this respect, the training programs to be implemented should cover all the incidents that the ARFF personnel may encounter in a realistic and challenging manner.

5.1. AC 150/5220-17B - Aircraft Rescue and Fire Fighting (ARFF) Training Facilities

This advisory circular has been prepared to guide users in the design, construction and operation of Aircraft Rescue & Fire Fighting Personnel (ARFF) training facilities. This guide contains information about both fixed and mobile training facilities fueled by hydrocarbon or propane. The aim of ARFF training facilities is to provide a safe training environment that can be visually and physically realistic, reproducible and documented. These provide safe and realistic use of the flame, heat and smoke effects and poor visibility that ARFF personnel may encounter when responding to real aircraft emergencies. A mobile or fixed ARFF training facility should have a combustion area, vehicle maneuvering area, aircraft simulator, control station, support systems, water distribution and water collection, fuel distribution and fuel collection, and electricity. The aircraft simulator to be used must be of a size and structure that represents the aircraft landing and taking off at the airport. In this airplane simulator, realistic airplane fires can be created with various scenarios. The aircraft simulator to be used can be stationary or mobile. While hydrocarbon and propane can be used as fuel in the stationary airplane simulator, propane is not allowed to be used as fuel in the moving airplane simulator. The primary consideration for the fuselage size and shape of the aircraft simulator is to provide a suitable target for the implementation of aircraft rescue and firefighting operations. Therefore, creating a reasonably realistic airplane section often fulfills the functional requirements of the airplane simulator. In all simulators designed for interior aircraft firefighting operations, the interior fuselage base must be able to carry loads loaded by those trained during rescue and interior firefighting operations. The tail part of the aircraft simulator can be with or without a motor, depending on the aircraft type. For rescue training in the aircraft simulator, there should be at least two doors on each side. (AC 150/5220-17B, 2010).

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5.2. NFPA 1402 Standard on Facilities for Fire Training and Associated Props

NFPA 1402 generally defines the training stations that should be in the fire training facility. These stations include an aircraft fire extinguishing and rescue station, which are covered extensively in Chapter 13 of this standard. One of the primary duties of ARFF crews is to assist cabin crew in aircraft evacuation by creating and maintaining a habitable area in the aircraft fuselage. In order to perform this task effectively, real aircraft and/or models can be used during the training and evaluation phase. Flame firefighting training should be aimed at improving the ability of firefighting personnel to work as a team during realistic and challenging training activities. Aircraft firefighting and rescue training simulators can be built with low-cost materials and equipped to use hydrocarbon fuels or the more environmentally friendly propane (NFPA 1402, 2012).

5.3. NFPA 402 Guide for Aircraft Rescue and Fire-Fighting Operations

This standard provides information on ARFF operations for airport and city fire brigades. Although some aircraft rescue and firefighting firefighters respond to structural fires, this standard does not address structural fires. Chapter 14 of NFPA 402 mentions the importance of aircraft fire extinguishing simulators in pre-event planning and training. As in all fire incidents, teamwork is a very important and vital issue in aircraft fires. Personnel in ARFF services should apply realistic pre-incident training against aircraft fires. Negative psychological factors that may arise related to aircraft firefighting activities can be eliminated with realistic training before the event occurs. It should be kept in mind that aircraft accident crash and firefighting activities, which are not certain when it will take place, can create stress for the personnel in ARFF services. It is important to use realistic aircraft simulators in order to increase the organizational skills of the personnel who respond to such events and to gain the ability to cope with stress. The aim here is to increase the knowledge and skill levels of the team before a real event. Preparing for aircraft accident crash and fire incident with firefighting drills is a good training for ARFF personnel. Although hydrocarbon fuels are generally used in this type of training, propane fueled simulators meet the needs with environmental laws and developing technology. On the aircraft simulator to be used in training; In-flight (cabin, cockpit), engine, landing gear, three-dimensional fire extinguishing scenarios should be applied. Performing firefighting training on a burning aircraft simulator using aircraft firefighting equipment and

hose lines can help fire specialist personnel develop knowledge, skills and confidence in such incidents. Training between military-civil airport and structural fire fighting units will provide coordination and effectiveness in joint response fire incidents (NFPA 402, 2013).

5.4. STANAG 7145 Minimum Core Competency Levels and Proficiency of Skills for NATO Fire Fighters

It is prepared for NATO member countries to bring their fire-specialized personnel to the level of mastery in the common core experience and skills necessary to protect aircraft, flight crew, weapons, mission-priority facilities and other resources from fires. According to STANAG 7145, it is compulsory for fire specialist personnel to attend flame fire extinguishing trainings. Flame firefighting training can be conducted with hydrocarbon (aircraft) fuels or the more environmentally friendly Liquid Petroleum Gas (LPG). STANAG also requires the flight crew, crew and passenger rescue trainings on the 7145 aircraft to be realistic and challenging. Especially for large-bodied aircraft, the issue of evacuation of passengers and protection of evacuation routes is an important issue that should be emphasized in trainings. Flame fire extinguishing training should be carried out in day and night conditions. Efforts should be made to construct a suitable flame-fighting training facility that does not harm the environment in order to carry out realistic and challenging trainings in order to meet the issues stated in this STANAG (STANAG 7145, 2014).

5.5. NFPA 405 Standard for the Recurring Proficiency of Airport Fire Fighters

Flame fire extinguishing trainings are mentioned in Chapter 15 of this standard. Flame firefighting training should use hydrocarbon fuel, propane, or a combination of the two. It is expected that fire-specialized personnel will be able to select an appropriate extinguishing agent using personal protective equipment and a hose line, and fully extinguish a fire in at least three of the six aircraft emergencies listed below, in accordance with their technique (NFPA 405, 2015).

- Internal fires,
- Auxiliary power unit (APU) fire,
- Engine fire,
- Landing gear / lining fire,

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- Electronic and electrical compartment fire,
- Three-dimensional fires.

5.6. NFPA 1003 Standard for Airport Fire Fighter Professional Qualifications

The main task of ARFF personnel is to carry out firefighting and rescue activities and they are required to fulfill all the requirements defined in Chapter 4 of this standard (NFPA 1003, 2015). ARFF personnel are required to obtain general information on the following subjects:

- Basic aircraft firefighting techniques,
- Use of personal protective equipment (PPE);
- Fire behavior,
- Firefighting techniques in oxygen-rich atmospheres,
- Reaction of aircraft materials to heat and flame,
- Critical components and hazards of civil aircraft manufacturing and systems related to RFF operations,
- Special hazards associated with military aircraft systems,
- Properties of different aviation fuels,
- Hazardous areas in and around aircraft,
- Aircraft fuel systems,
- Aircraft exit / entrance (covers, doors and chutes),
- Hazards related to air cargo, including dangerous cargoes,
- Critical stress management policies and procedures

5.7. AC 150/5210-17C Programs for Training of Aircraft Rescue and Firefighting Personnel

The AC 150/5210-17C provides information on course and reference materials for training ARFF personnel. ARFF personnel must participate in a fire extinguishing exercise at least once every 12 months. In order for this exercise to be a realistic and challenging training, an aircraft simulator and sufficient fuel should be used. The training scenario should include the types of fires that can be encountered on the aircraft at the airport/airport where they are assigned. The trainings should be in a way that allows the use of materials and equipment that ARFF personnel can use in a real accident and fire incident, so that the confidence and skills of ARFF personnel can be developed against a real incident that they will encounter. The casualty dummies to be used on the plane will also help create a

realistic simulation. It is important that aircraft simulators to be used in flame fire extinguishing trainings are designed in such a way as to help ARFF personnel develop their ability to use hose lines and vehicle turrets (monitors). However, turret use alone is unacceptable in flaming aircraft firefighting training. Therefore, hose lines must be used in trainings. During the trainings, ARFF personnel should learn how to protect both the aircraft crew and passengers from the flames, and to keep the escape routes safe, with aircraft fire extinguishers. The fuel for the aircraft simulator to be used for flame firefighting training can be hydrocarbon or propane (AC 150 / 5210-17C, 2015).

5.8. ICAO Doc. 9137-AN/898 Part-1 Rescue and Fire Fighting

The effectiveness of the rescue efforts carried out to save the survivors of an aircraft accident that no one desires depends on the training received by the ARFF personnel, the efficiency of the equipment used in the rescue and extinguishing activities, and the correct, effective and short-term operation of the personnel assigned to the ARFF services. Personnel performing ARFF services rarely respond to a large aircraft accident or fire. Therefore, with a well-planned and well-executed training program, they can overcome a major aircraft accident and fire, as their knowledge and skills will rarely be put to the test, except in a few simple emergencies. The training programs prepared should ensure the development of the ability to work at the individual and team level so that ARFF personnel are always available for emergencies (ICAO Doc 9137-AN/898, 2015).

5.9. FAA 14 CFR Part 139-319 Aircraft Rescue and Fire Fighting, Operational Requirements

All ARFF personnel must attend at least one firefighting training prior to the initial performance of rescue and firefighting duties and no later than 12 months after enlistment (FAA 14, 2018).

5.10. SHT-HES REV2 General Directorate of Civil Aviation Airport Safety Standards Instruction

It is important that ARFF personnel receive appropriate training for ARFF services and participate in firefighting training appropriate to the aircraft types and RFF equipment being used at the airport, including pressurized fuel fires (SHT-HES REV2, 2018).

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CONCLUSION

High Reach Extendable Turret (HRET) System is very effective not only in interior fires, but also in fires in different areas. It has many advantages as well as disadvantages. The important thing is to constantly consider the disadvantageous factors during use and to take precautions against it.

Internal fuselage fires pose a great risk to aircraft. This is because the entire fire load is accumulating in this area. High Reach Extendable Turret (HRET) System has been specially produced for use in fires in this region. However, despite being such a useful system, it is not widely used, especially in our country.

Since airport firefighting vehicles are special production vehicles, their cost is higher than other fire extinguishing vehicles. High Reach Extendable Turret (HRET) System also adds additional cost to these vehicles. Often, providers do not provide these featured tools to avoid cost, ignoring the benefits of the High Reach Extendable Turret (HRET) System.

Along with all the factors, attention should be paid to the regular maintenance of the system. The system, which will not work at the time of the event, will bring us more harm than good, despite all its qualities.

As a result, firefighting vehicles with High Reach Extendable Turret (HRET) System are particularly effective in interior hull fires. In national and international norms, a separate parenthesis should be opened for these tools and supply should become mandatory. This will create fully equipped fire crews and increase the success rate in combating aircraft interior fires.

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