AIR FORCE

FIRE EMERGENCY SERVICES

AIRCRAFT RESCUE

AND

FIRE FIGHTING

RESPONSE GUIDE

September 2014

TABLE OF CONTENTS

Supersedes: This edition of the Air Force Aircraft Rescue and Fire Fighting Response Guide supersedes all previous editions.

INTRODUCTION

1. Purpose. The purpose of this guide is to clarify the Air Force (AF) implementation of Department of Defense Instruction (DoDI) 6055.06, *Department of Defense Fire and Emergency Services Program* (21 December 2006), AFI 32-2001, *Fire Emergency Services (FES) Program* (27 February 2014), and National Fire Protection Association (NFPA) Standard 403, *Aircraft Rescue and Fire Fighting Services at Airports* (2014 Edition), relative to aircraft rescue and fire fighting (ARFF) operations. This guide provides a template for Major Air Commands (MAJCOMs) and base-level senior fire officials (SFOs) to utilize during assessments and to effectively communicate ARFF capabilities to MAJCOM, their Base Civil Engineer and wing leadership. Furthermore, it consolidates existing AF and applicable National Fire Protection Association (NFPA) criteria pertaining to response criteria, staffing and vehicle requirements, and it outlines the use of a risk assessment process. This guide also contains a sample fire protection risk management assessment model as well as air show fire fighting guidance.

2. Background. DoDI 6055.06 contains ARFF response criteria pertaining to response time, fire fighting vehicle agent requirements, and ARFF fire ground staffing. The AF uses Air Force Instruction (AFI) 32-2001, *Fire Emergency Services Program*, Allowance Source Code (ASC) 010, *Vehicle Fleet (Registered) All MAJCOM Common*, and Air Force Manpower Standard (AFMS), *Fire Protection Flight 44EF00*, as the means to identify service specific requirements to implement DoDI 6055.6. The AF ARFF vehicle sets listed in ASC 010 have been adjusted by implementation of the Vehicle Validation and Realignment Plan (VVRP) (Updated 12 September 2012) and are consistent with NFPA 403 airport categories, agents, and vehicle requirements.

3. Discussion. The key to an effective ARFF program is having the ability to deliver sufficient fire fighting agent within a limited amount of time. The goal of the AF ARFF program is to provide protection for aircrews, passengers, aircraft, and on-board weapons, while preventing and/or reducing collateral damage to any exposed property. A thorough understanding of ARFF response criteria, vehicle capabilities, and staffing requirements will enable SFOs to effectively execute DoD and AF implementation instructions. SFOs are responsible for utilizing available resources to the fullest extent possible and must notify senior leadership, using a Risk Management (RM) process, when fire protection capabilities fall below mission requirements. A comprehensive fire risk management plan, supported by documented RM assessments, provides information for both the MAJCOM CE and wing leadership to make key risk-acceptance decisions.

4. Aircraft Rescue and Fire Fighting Response Guidance. Several factors must be considered when determining ARFF response criteria. These factors include response time for announced and unannounced aircraft emergencies, staffing and vehicle requirements, and the use of a risk assessment process.

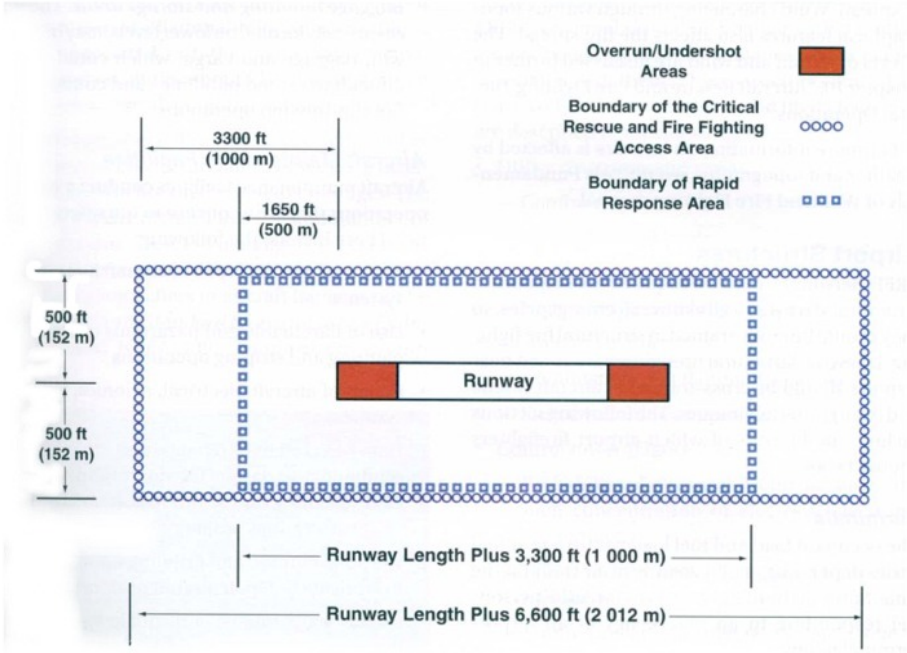
SECTION 1 – AIRFIELD/RUNWAY LAYOUT

5. Critical Rescue and Fire Fighting Access Area.

5.1. DoDI 6055.06 incorporates NFPA 403 concepts and requirements as the baseline for ARFF response criteria. This criteria identifies a specific area of an airfield where the majority of aircraft flight or ground related fire incidents have historically occurred. This area is known as the *Critical Rescue and Fire Fighting Access Area* (CRFFAA). The CRFFAA is defined as the rectangular area surrounding any runway within which most aircraft accidents can be expected to occur on airports. Its width extends 500 feet from each side of the runway centerline, and its length is 3,300 feet beyond each runway end.

5.2. The CRFFAA contains an area known as the *Rapid Response Area* (RRA). The RRA is defined as a rectangle that includes the runway and surrounding areas extending to, but not beyond, the airfield property line. Its width extends not more than 500 feet to either side of the runway centerline, and its length is 1,650 feet beyond each end of the runway. According to the NFPA, approximately 85 percent of aircraft incidents as historically recorded in the CRFFAA occurred within the boundary of the RRA.

5.3. The diagram below reflects the boundaries associated with the CRFFAA and RRA. When siting a new crash fire station, consideration must be given to the station's location and its relationship to the RRA.



SECTION 2 – RESPONSE TIME

6. ARFF Response Time Requirements.

6.1. ARFF response requirements for Air Force installations are contained in DoDI 6055.6 and clarified in AFI 32-2001 and the NFPA 403-14 Technical Implementation Guide for NFPA 403, *Standard for Aircraft Rescue and Fire-Fighting Services at Airports*. These response requirements are established for two flight related aircraft emergency scenarios – announced and unannounced emergencies.

6.1.1. **Announced -** ARFF apparatus (pre-positioned) will be capable of responding to any incident/accident on the runway(s) within 1 minute.

6.1.2. **Unannounced -** ARFF apparatus will be capable of responding to any incident/accident on the runway(s) within 5 minutes.

6.2. Response Times:

6.2.1. Alarm Handling Time: The time interval from the receipt of the alarm at the primary PSAP/FACC/ECC until the beginning of the transmittal of the response information via voice or electronic means to the appropriate fire station(s) or emergency response units in the field.

6.2.2. Turnout Time: The time interval that begins when the fire station(s) and emergency response unit(s) notification process begins (by either an audible alarm or visual annunciation or both) and ends at the beginning point of travel time. The first firefighting vehicle that can mitigate the call must sign out "in-service" as the vehicle turns a wheel in transit. This is the end of turnout time, but will **NOT** begin travel time for announced emergencies due to the unknown landing timeframe.

6.2.3. Travel Time: For an announced emergency, Travel Time begins when the IC announces that the aircraft has come to a complete stop which will count as the beginning of response time. Travel Time ends when the first firefighting vehicle announces it is on scene and is in position to apply agent.

6.2.3.1. For an unannounced emergency, Travel Time begins at the end of Turnout Time and ends when the first vehicle has arrived at the incident scene and is in position to apply agent.

6.2.4. Fire departments must account for initial response, but also full alarm response. For both announced and unannounced emergencies, the remaining ARFF vehicles in the Full Alarm Response are expected to arrive at 30-second intervals.

6.2.5. The notification of the ARFF crews is normally through the activation of the Primary Crash Phone that initiates a specific tone/audible alarm and/or public address system in the ARFF station(s) which notifies (alerts) the ARFF crews that an aircraft emergency exists. If the ARFF station(s) does not have that capability, as recommended in Annex C to NFPA 403, then the installation fire chief shall pursue obtaining that capability.

6.3. ARFF standbys and the protection of areas other than the movement areas: These requirements are established by TO 00-25-172, *Ground Servicing of Aircraft and Static Grounding/Bonding.*

6.3.1. Aircraft Parking and Maintenance Ramps: NFPA 403 is focused on providing life-safety at conventional airports in the public sector. As such, it does not necessarily address all of the ARFF issues associated with Air Force installations with a flying mission. For example, AF installations such as Air Logistics Complexes (ALCs) and test centers may have substantial aircraft maintenance and testing operations on ramp areas that NFPA 403 doesn't consider due to its focus on passenger/crew life safety.

6.3.2. On AFMC's ALCs, flight test center, and weapons development centers, a majority of the aircraft fires, explosions, and other aircraft emergency events have historically occurred on ramps where maintenance and testing operations are routinely conducted. On such installations, there may be a critical need to include the same ARFF response criteria as NFPA 403 applies to the RRA. In all cases, the MAJCOM FES representative is authorized to include specific maintenance and testing ramps in the RRA based on historical aircraft emergency events. The RM assessment process should be used to determine when ARFF resources are warranted or not warranted. Such RM assessments and decisions should be accomplished in conjunction with the local OPRs for the aircraft and aircraft operations.

6.3.3. Local fire officials may determine when unique or unusually-hazardous ramp operations warrant special operations, which could include increased ARFF ramp surveillance; ARFF stand-by services during peak hours of maintenance; increased fire prevention training on hazard recognition, and the use of flightline fire extinguishers by maintenance personnel.

7. Concept of ARFF Response Time.

7.1. Consistent with the National Technology Transfer Act of 1995 (Public Law 104-113) directive to use industry standards whenever appropriate, DoDI 6055.06 (Enclosure E3.5 ARFF Response) adopted the agent and airport category requirements of NFPA 403, as modified by the Vehicle Validation and Realignment Plan (Updated 12 September 2012). The Air Force implemented this requirement in ASC 010 vehicle sets. The Air Force retained the DoDI's 5-minute response time as the baseline for ARFF responses as defined in paragraph 6.1.2.

7.2. The following table provides a comparison of Federal Aviation Administration (FAA), NFPA, DoD, and Air Force ARFF response times.

Response Time	FAA	NFPA		DoD	Air Force
Starting Time for Response Measurement	Upon Receipt of Alarm Notification	Upon Receipt of Alarm Notification		Upon Receipt of Alarm	Time of ARFF Crew Notification
Specific Location to which ARFF Vehicles Must Respond	Mid-Point of the Runway	Any Point on the Runway	Any Point within the RRA that is within the Airport Boundaries	Any Point on the Runway	Any Point on the Runway(s)
Response Time for 1st Arriving ARFF Vehicle	3 minutes	2 minutes	2½ minutes	5 minutes*	5 minutes*
Response Time for Additional Required ARFF Vehicles	4 minutes	30 second Intervals	30 second Intervals	No Criteria	30 second Intervals

***** The DoD and Air Force have established a 5-minute aggregate response time for *unannounced emergencies* and a 1-minute response time for pre-positioned ARFF vehicles responding to *announced emergencies* as described in Section 2.

7.3. This Air Force criteria is based on decisions that were made by senior Air Force civil engineer leadership as a result of the 1996-1998 Bottom-Up Review (BUR) of crash rescue services and the implementation of the Vehicle Validation and Realignment Plan. The decision was based upon using existing crash fire station locations and apparatus to provide the best level of protection with available resources. The historical locations of the majority of airfield incidents within the RRA and aircrew survivability were also considered.

8. Measurement of ARFF Response Time. Response time can be measured by one of three methods.

8.1. Historical Response Time Data: Historical fire department logs may provide the best indication of real response times. A review of fire department logs for at least the past 24 months should determine actual response times to specific areas within a RRA.

8.2. Plotting Using a Grid Map: An alternative to historical records is plotting response patterns on a scaled base grid map may be used. The following table provides data for estimating the time to travel specific distances.

Miles Per Hour	Feet Per Second	Feet Per Minute	Travel Time *
25	37.9	2,275	5:15 min
30	44.0	2,640	4:30 min
35	53.1	3,186	3:45 min
40	58.7	3,520	3:25 min
45	66.0	3,960	3:00 min
50	73.3	4,400	2:45 min
55	80.7	4,840	2:30 min
60	88.0	5,280	2:15 min

***** Travel time calculations are based on the time to travel the length of a 12,000-foot runway. These travel time calculations **do not** take into consideration vehicle acceleration, vehicle impairments, interference caused by aircraft movement, or local weather conditions.

8.3. Computer Models: The ideal tool for estimating emergency travel times, assuming historical records are not available, is a computer model that accounts for airfield configuration, taxiway or airfield intersection and interdiction controls, local emergency response speed limits, and airfield traffic patterns.

Note: Time trials should be conducted as close as possible to actual emergency responses. When responding to an incident, emergency vehicles should follow the guidelines contained in NFPA 1500, *Fire Department Occupational Safety and Health Program* (2013 Edition).

SECTION 3 – STAFFING AND VEHICLE REQUIREMENTS

9. Staffing Requirements. The foundation for AF peacetime fire protection staffing and standards of ARFF emergency response coverage is based on DoDI 6055.06 and implemented by AFMS, *Fire Emergency Services Flight 44EF00*. The AFMS has identified the core fire ground tasks associated with effective firefighting tactics. In addition, the AF has established variances that take into consideration unique mission requirements and base configurations. The AFMS application is accomplished by the local Manpower and Organization Office and validated by each MAJCOM Fire Emergency Services (FES) office. The Fire Chief and MAJCOM FESs should review that data annually for currency. Application of the AFMS should be maintained as an official record on file at both the fire department and MAJCOM FES offices.

10. Vehicle Requirements. ASC 010 provides the authorization for a core vehicle set that includes ARFF, structural, and fire fighting support vehicles for an installation. The ARFF vehicles are a combination of 500 to 3,300 gallon vehicles that are included in 6 vehicle sets.

11. Relationship of Staffing and Vehicles to Standard of Cover (SOC).

11.1. SOC defines a predetermined fire fighting capability predicated upon a specific level of fire department resources (staffing, vehicles, equipment, and fire station locations). If any one of these critical resources is not available, mission objectives cannot be fully accomplished. It is important to understand that an efficiently staffed ARFF vehicle *can accomplish* initial offensive aircraft fire ground operations upon arrival. See AFI 32-2001 for Air Force approved levels of service policy requirements and guidance.

11.2. Conversely, inadequately staffed ARFF vehicles *cannot accomplish* initial offensive aircraft fire ground operations. Fire chiefs need to articulate shortfalls to their Base Civil Engineer and wing leadership and explain how such shortfalls impact mission support capabilities. These impacts can result in loss of life or property, reduce operational processes and/or mission continuity, or lead to potential damage to the environment. The impact of these shortfalls, not in priority order, includes:

11.2.1. Execution of offensive versus defensive fire ground operations.

11.2.2. Inability to conduct interior search and rescue.

11.2.3. Firefighting or rescue operations may be precluded due to OSHA’s 2 In/2 Out rule (29 CFR 1910.134).

11.2.4. Compromises safety of firefighters on the fire ground.

11.2.5. Reduces potential airframe salvage value.

11.2.6. Increases in aircraft loss severity.

11.2.7. Impairs on-scene re-supply capability required for a sustained fire fighting attack.

11.2.8. Degrades the effectiveness of the Incident Command (IC) structure.

SECTION 4 – RISK ASSESSMENT PROCESS

12. Risk Management.

12.1. The principles of RM requires that fire fighting crews not accept unnecessary risks, make decisions at the appropriate level, accept risk when the benefits outweigh the costs, and integrate RM into doctrine and planning at all levels. Under no circumstances should reduced capability subject ARFF personnel to unacceptable risk. Risk management is an essential consideration when developing an operational plan.

12.2. Each Air Force ARFF vehicle set was designed to provide a surplus amount of agent for each specific aircraft requirement in IAW NFPA 403 Q factors. This additional agent accounts for periods of vehicles Out of Service (O/S), potential deployment of vehicles, and aids in supporting larger transient type aircraft. Q factors 1, 2 & 3 are the required amount of agent needed to extinguish a fire. Q factors have been accomplished for all DoD assets and many civilian airliners, Q factors for each AF aircraft are provided at Attachment 1. Q factors are defined as:

*Q^1 – Quantity of water for foam production for initial control of the pool fire.
*Q^2 – Quantity of water for foam production to continue or fully extinguish the pool fire.
*Q^3 – Water available for interior firefighting.

12.2.1. When calculating the level of risk for O/S vehicles, risk managers should consider each specific airframes Q factor when determining if risk mitigation measures need to be instituted. The Q factors are the agent required to successfully extinguish a fire exterior and interior.

Example: Vehicle Set 4 – ASC 010 provides 8,000 gallons, NFPA 403 requires 7,780 gallons - Set 4 (P-23/3,000 gallons, P-23/3,000 gallons, P-19/1,500 gallons, and the P-34/500 gallons)

Using the C-17A aircraft for this example the agent required to meet NFPA $Q^1 + Q^2 + Q^3$ equals 6,864 gallons of water for fire extinguishment.

Using the example of a P-19 going O/S; understanding your mission assigned aircraft Q factors require 6,864 gallons for fire extinguishment, with a P-19 O/S you are now at a 95% mission capability rate for ARFF. Your ARFF capability is still “green” according to AF standards.

12.3. Deviations from the ASC 010 vehicle sets (e.g., large frame transit aircraft, ARFF vehicle outages, or reduced staffing) must be addressed through an RM assessment. The RM assessment must be coordinated through appropriate management levels IAW AFI 32-2001 to inform local leadership of operational limitations.

13. Risk Assessment Conditions.

13.1. The Air Force uses the RM process described in AFPAM 90-803, *Risk Management Guidelines and Tools* to perform risk assessments. Some installations may identify deficiencies when accomplishing an assessment. These deficiencies could include staffing shortages, reduced

vehicle availability, and operational limitations, and may result in the necessity to perform a formal RM assessment.

13.2. The following are examples of conditions that potentially reduce ARFF capability and may present an increased risk to support the flying mission. These conditions should be addressed and documented in the department's RM plan.

13.2.1. Staffing: Qualified personnel are not available to staff vehicles (i.e., deployments, emergency leave, extended and short notice sick leave, hiring limitations, etc.).

13.2.2. Vehicle Availability: Vehicles are not available for use (i.e., extensive maintenance, depot overhaul, accident repair, deployment support, etc.).

13.2.3. Operational Restrictions: Restrictions may include, but not be limited to airfield construction impacts ramp/runway access, severe weather/climatic conditions, combination fire station location inappropriately sited, runway access, aircraft operational standbys, extensive operations that prohibit withdrawal for other responses (e.g., hazardous material, confined space rescue, medical, etc.).

13.2.4. When assessing the condition, the AF has determined there to be four levels of service;

13.2.4.1. Optimum Level of Service (OLS), 100 to 90% (Green). The level of service where all authorized resources are available for emergency response within response time standards. OLS provides sufficient capability for quick response and sustained operations after arrival on scene. During OLS, emergency response forces accomplish all feasible FES objectives when responding to emergency incidents.

13.2.4.2. Reduced Level of Service (RLS), 89 to 70%, (Yellow). The level of service when Emergency Response Capability (ERC) is less than OLS but greater than CLS. Sufficient capability is provided for initial response, scene assessment and implementation of mitigation tactics. This level of service represents increased risk/loss potential due to lack of ERC to perform rescue and sufficient mitigation tactics simultaneously. FES objectives may not be successful during situations where simultaneous rescue and fire fighting activities are required.

13.2.4.3. Critical Level of Service (CLS), 69 to 60% (Red). A CLS capability exists when 7 firefighters are available to respond to an emergency within the response time standards. Aircraft emergencies must meet established response time criteria for announced and unannounced emergencies. Upon arrival, the Incident Commander will determine the appropriate actions to be taken depending upon their initial evaluation of the situation. Successful outcomes can only be expected when the incident can be quickly mitigated. Firefighters are expected to revert to defensive operations when the emergency cannot be quickly contained.

13.2.4.4. Inadequate Level of Service (ILS), <60%. ILS is when the ERC for a CLS is unavailable. The property involved in the fire is expected to be destroyed.

13.2.5. At OLS, staffing is available to reasonably ensure successful outcome at most emergency incidents. However, RLS is expected to occur frequently and for extended periods at most installations. At any LOS, the IFC will allocate available resources based upon assessment of local risks, with the goal of maintaining at least CLS within the response time standards.

14. Sample Fire Protection Risk Management Assessment Exhibit. An accurate RM assessment will result in using factual data from the calculations in paragraph 12.2 above and should be presented to the Base Civil Engineer and senior Wing leadership. ARFF fire fighting capability will be described by determining the Level of Service (LOS) for each type of aircraft. The ARFF chart below is an example that can be used to determine the LOS for each particular AF aircraft category. This chart presents a direct correlation between staffing levels and fire fighting agent. LOS definitions found in AFI 32-2001 clearly articulate FES capabilities and enable Wing leadership to make sound decisions. This will provide the Wing Commander with guidance on RM actions, standardized NOTAM messages and the need to request waivers.

Aircraft Type & AF Vehicle Set		**Optimum Level Service OLS**		**Reduced Level Service RLS**		**Critical Level Service CLS**		**Inadequate Level Service ILS**		**Assigned - Normal Level of Service**	**Today's Current Level of Service**
Aircraft	AF Vehicle Set	OLS Firefighters	OLS - Gallons ASC 10 & $Q^1+Q^2+Q^3$	RLS Firefighters	RLS - Gallons Q^2+Q^1	CLS Firefighters	CLS - Gallons Q^1	ILS Firefighters	ILS Gallons	Assigned Aircraft AF Vehicle Set 1-6	Date & Time:
F-16, A-10, C-21, F-15, F-22, T-37B, BQM-34, RQ-1A/B, T-38, AT-38, MQM-107, T-6A, UV-18, QF-4, CV-22, UH-1N, C-38A, T-1, RQ-4, C-12, F-35, F-117, F-22	1	14	2,500 - 1,340	13 - 8	1,339 - 513	7	512 - 325	4	324	OLS	OLS
C-20	2	14	4,000 - 2,760	13 - 8	2,759 - 1,316	7	1,315 - 752	4	751	OLS	OLS
C-9, C-40, C-130, E-3, E-8,T-43,C-37,MH-53,C-32,C-22,RC-135	3	14	5,000 - 4,880	13 - 8	4,879 – 3,027	7	3,026- 1,322	4	1,321	OLS	OLS
C-17, B-1, B-2, B-52, KC-135, KC-46	4	16	8,000 - 7,780	15 - 8	7,779 - 4,364	7	4,363 - 1,732	4	1,731	Assigned Cat 4	RLS
VC-25, KC-10, E-4 (747), MD-11	5	17	10,000 - 9,570	16 - 8	9,569 - 6,292	7	6,291 - 2,330	4	2,329	RLS	CLS
C-5	6	18	13,000 - 12,626	17 - 8	12,625 - 7,508	7	7,507 - 2,589	4	2,588	CLS	CLS

Note: This is a sample RM Assessment Exhibit. Actual gallons should be calculated by using the percentages in paragraph 12.2 and the equivalencies in Section 16 based on local risk assessments.

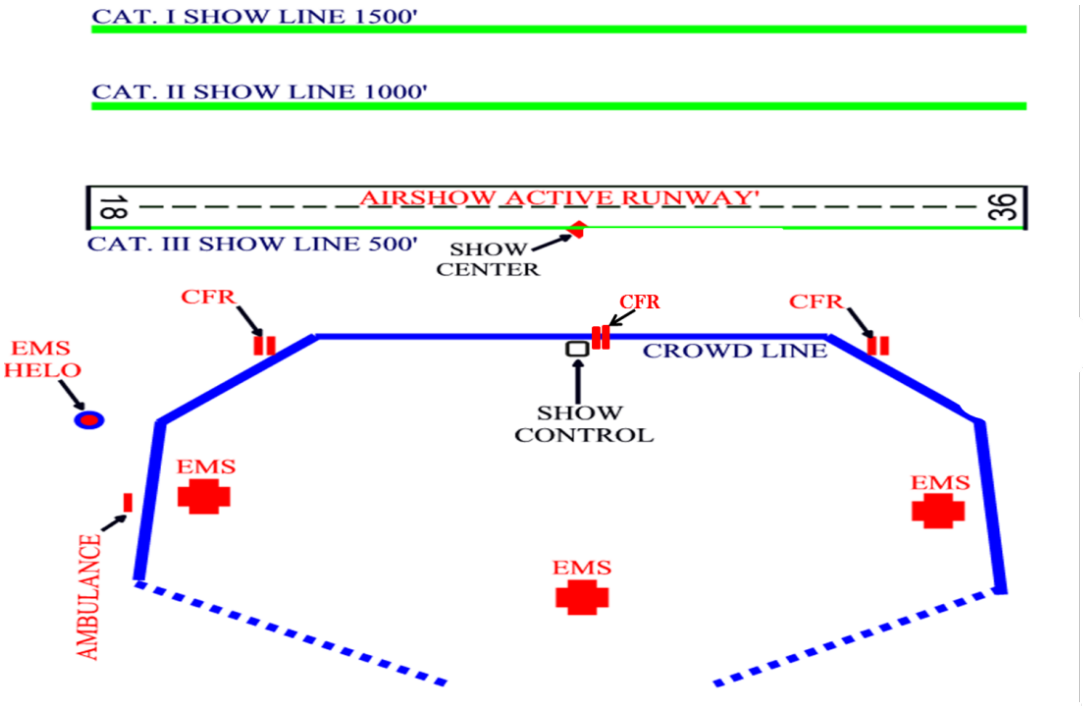
SECTION 5 – AIR SHOW SAFETY

15. **Air Show Safety.** As one of the leaders on aircraft fire fighting and emergency response, we must do all that we can do to ensure both performer and public safety during air shows hosted on Air Force installations.

15.1. In recognition of the non-standard environment in which air shows are conducted, the non-standard aircraft that often fly at these events and the non-standard manner in which those aircraft are flown, the following guidelines must be adhered to during air shows.

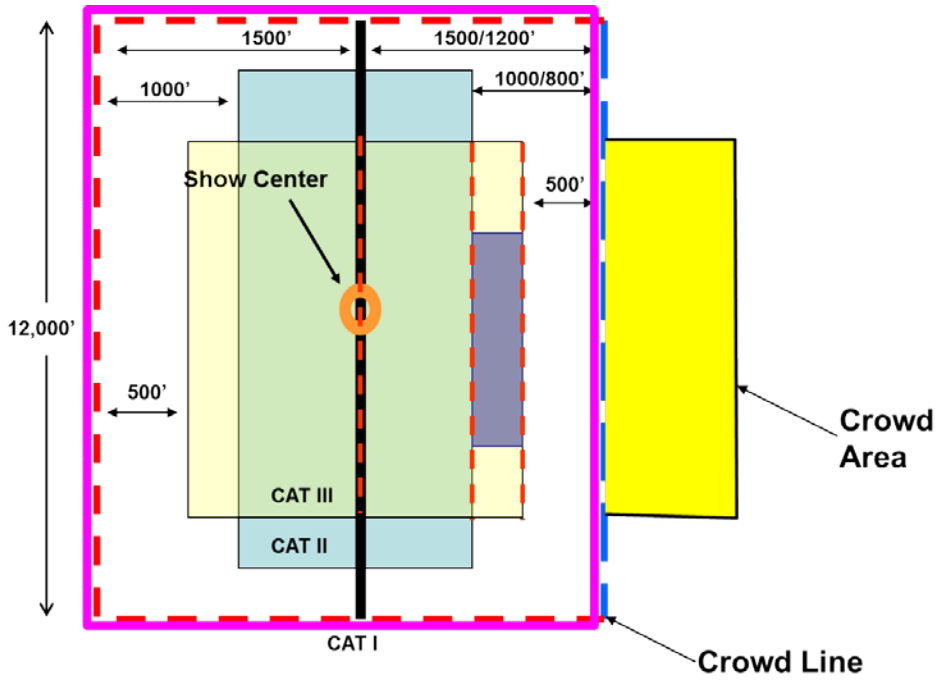
15.2. ARFF vehicles must be tactically prepositioned to provide the shortest and most direct routes to the show center. In all cases, ARFF vehicles must not be positioned behind the crowd line and should not be staged in the fire station.

15.3. ARFF vehicles and Crash Fire Rescue (CFR) personnel will be deployed to the right and left of the air show/open house crowd area with unimpeded access to the area in which air show flight operations are conducted. In addition, an ARFF vehicle (preferably a P-34 Rapid Intervention Vehicle (when available)) will be positioned at or near show center. All deployed vehicles will be positioned so that they have an unobstructed line of sight on the whole airfield, specifically, the aerobatic box in which the majority of the air show flight operations are conducted. Historically, during almost all air show incidents, the aircraft wreckage comes to rest within the aerobatic box. By positioning ARFF vehicles at each end of the crowd area and one at show center, our response time will improve and may save lives.



Typical Air Show Lay-Out

15.4. The Aerobatic Box. The Federal Aviation Administration (FAA) defines the aerobatic box as the airspace at an air show where participating aircraft are authorized to perform aerobatic maneuvers appropriate to their Category (CAT). This box begins at the appropriate CAT I/II/III show line shown below.



The Aerobatic Box

Note: The two-dimensional parameters of the aerobatic box are defined by the bright pink line. In addition to these two dimensions, there is a third dimension to the aerobatic box that ensures that the airspace in which air show flight operations are conducted is sterile. That third dimension varies (based primarily on the type of aircraft that are performing) from as low as 3,000 feet to as high as 20,000 feet.

15.4.1. The aerobatic box is the sterile area in which air show flight operations are conducted. The boundaries, dimensions and parameters of the aerobatic box are clearly and specifically defined as part of the application that air show organizers submit to the FAA to receive authorization to conduct an air show.

15.4.2. A written or graphic illustration of the aerobatic box must be presented to performers and emergency response personnel during the pre-air show safety briefing.

15.5. The entire period during which the aircraft are flying during the air show will be treated as an "announced" emergency.

15.6. ARFF personnel will be staged to respond immediately to any incident or accident. Friends and family will not be located in the area of ARFF vehicle positions. Additionally, folding

chairs or any other obstructions should never be positioned in front of pre-positioned ARFF vehicles.

15.7. ARFF personnel will don their firefighter PPE and the vehicle engines will be running throughout the entire active flying portion of the air show.

15.8. ARFF personnel will be expected to respond in such a manner that they may deploy fire fighting agent within 1-minute following an incident/accident on or near the runway used to conduct the air show.

15.9. To ensure clear lines of communications, the incident commander should consider positioning himself/herself or a liaison with the air boss throughout the air show.

15.10. Prior to the air show and not later than the first safety briefing on the rehearsal/practice day of the air show (typically Friday at most shows), firefighters will meet with the air show operations officer, the air show air boss and appropriate air traffic control personnel to discuss procedures and methods to reduce the standard radio communications and runway/taxiway clearances required for ARFF personnel to respond to an incident/accident during the air show. These procedures and methods will be developed with the goal of allowing firefighters to respond to an incident/accident without being delayed by procedural or communications issues.

15.11. Prior to the beginning of air show flight operations, at least one firefighter from each ARFF vehicle deployed in support of the show should make themselves available to meet with the pilot-in-command of each aircraft participating in the air show/open house to discuss emergency extraction, canopy release, fuel shut off, master switch on/off switch and aircraft lift points. If the firefighters are different on subsequent days of the event, at least one firefighter should make themselves available to each pilot and other firefighters to re-brief the emergency response information.

15.12. In consultation with the air show operations officer and the air show air boss, firefighters will be available to conduct an emergency response drill on the practice/rehearsal day of the air show (typically a Friday for a Saturday/Sunday event). See the attached document describing procedures for conducting an air show emergency response drill.

SECTION 6 - EQUIVALENT FIRE FIGHTING CAPABILITY

16. Comparing Firefighting Technology. Firefighting vehicles equipped with ultra-high-pressure (UHP) firefighting technology, compressed air foam (CAF) technology, or combined agent firefighting system (CAFFS) technology can extinguish fuel fires with less agent than traditional low-pressure (LP) ARFF trucks. The greater capability offered by these technologies can be considered when evaluating, factoring and developing RM. For example, a 1,500- gallon P-19 ARFF vehicle equipped with UHP technology would be expected to perform comparable to a standard LP ARFF vehicle having 3,333-gallons of AFFF capacity, and the 500-gallon P-34 RIV is capable of performance comparable to a LP ARFF vehicle having 1,111-gallon AFFF capacity. Calculations of equivalent performance using Table 1, below, are for comparison purposes only. When calculating the agent required to meet capacity requirements listed in Table 5.3.1 of NFPA 403, the actual vehicle water capacity must be used and not the equivalent capacity expected from these alternative technologies. For the UHP example above, the actual water capacities, 1500 and 500 gallons, respectively, and not the comparable UHP firefighting capability, are to be used to meet NFPA 403 water capacity requirements.

16.1. Research and Development Effort. The capability to extinguish liquid fuel fires involving aircraft is dependent primarily on an adequate number of trained firefighters equipped with sufficient means to apply the agent to a fire. The Fire and Emergency Services research and development organization at Tyndall AFB, FL (previously the Air Force Research Laboratory and now AFCEC/CXA) conducted research and development between 2004 and 2009 to develop fact-based methodology to compare different technologies and agent combinations to traditionally available fire extinguishing agents. In addition to assessing technology, the project baselined existing LP AFFF turret streams from the P-19 ARFF vehicle, the workhorse of aircraft fire fighting in the DoD. The project measured the effectiveness of agents already in use and combinations of those agents against the baseline.

16.2. The most extensive evaluations focused on comparing the effectiveness of agents applied with new technologies or in combination with other agents to the effectiveness of standard 3% AFFF solution applied with a standard P-19 ARFF vehicle. Table 1 provides the results of the series of tests conducted for each technology using turrets.

Table 1. Turret Application				
	Application Rate for Extinguishing (gallons of agent per ft^2 pool fire area)	**Equivalent NFPA Critical Application Rate (gallons of agent per ft^2 pool fire area)**	**Quantitative Agent Requirement (Technology Factor)**	**Minimum Turret Flow Rate (gallons per minute)**
UHP	0.020[1]	0.059	0.45	60
CAF	0.038[1]	0.11	0.85	125[2]
CAFFS	0.023[1]	0.068	0.52	125[2]
LP AFFF	0.044[2]	0.13	1	250[2]

[1]Details provided in technical report, AFRL-RX-TY-TR-2010-0033, Field Demonstration of a Centrifugal Ultra High Pressure (UHP) P-19, March 2010.

[2]Details provided in technical report, AFRL-ML-TYTR-2004-4554, Fire Extinguishing Effectiveness Tests, November 2004.

16.3. Table 1 can be used to determine comparable performance of a given quantity of agent based on the firefighting technology used to apply the agent. The equivalency relationship is:

E = Q/T, or Q = ET, where

E = Equivalent quantity

T = Technology Factor (from Table 1, above)

Q = Quantity available

EXAMPLE: The standards require a P-19 vehicle for a special contingency operation. A CAF vehicle is available commercially with 300 gallons of AFFF solution that would be easier to transport and is readily available. You want to know if the vehicle has performance equivalent to the P-19:

E_{CAF} = Q (300 gal) / T_{CAF} (0.85) = 352 equivalent gallons of AFFF applied at standard pressure

The vehicle is equivalent to only 352 gallons of AFFF, about one-third the equivalent capacity of a standard P-19. For a vehicle equipped with CAF technology, how large of a tank would the vehicle need to be equivalent to the capacity of a standard P-19?

Q_{CAF} = $E_{P\text{-}19}$ (1000 gal) × T_{CAF} (0.85) = 850 gallons of AFFF

A vehicle equipped with CAF technology would need an 850-gallon water tank to have firefighting capability equivalent to a standard 1000-gallon P-19.

16.4. While the equivalent quantity of agent can be estimated based on results from a large number of actual fire tests, other factors that affect the firefighting ability of ARFF vehicles, like flow rate and stream reach, are not as well documented in tests and consequently are not easy to predict. However, based on the specific equipment used in actual fire tests the flow rates listed in Table 1 are the recommended minimums for comparable performance.

NFPA Category 1-4 Airports by Aircraft Type	Fuselage Length	Fuselage Width	TCA Sq Ft L x (K+W)	PCA Sq Ft .66 x TCA	NFPA Airport Cat Table 4.3.1	NFPA Q-1 .13 x PCA x 1	NFPA Q-2 Q2% x Q1	NFPA Q-3 Table B.5.3	Total Q1+Q2+Q3 Gallonage Required	NFPA 403 Gallonage	AF ASC010 Gallonage	AF Vehicle Set
T-37B (Tandem)	29 FT 3 IN	5 FT 0 IN	1258	830	1	108	0	0	108	120	2500	1
BQM-34	28 FT 5 IN	1 FT 2 IN	1141	753	1	98	0	0	98	120	2500	1
RQ-1A/B	27 FT 0 IN	3 FT 7 IN	1150	759	1	99	0	0	99	120	2500	1
T-38A	25 FT 3 IN	5 FT 0 IN	1111	733	1	95	0	0	95	120	2500	1
AT-38B/C	25 FT 3 IN	5 FT 0 IN	1111	734	1	95	0	0	95	120	2500	1
MQM-107	18 FT 0 IN	1 FT 0 IN	720	475	1	62	0	0	62	120	2500	1
T-6A	33 FT 4 IN	5 FT 0 IN	1457	968	2	129	34	0	163	200	2500	1
UV-18	51 FT 5 IN	5 FT 9 IN	2660	1756	3	228	68	300	593	670	2500	1
QF-4	58 FT 3 IN	5 FT 0 IN	2971	1961	3	255	76	300	631	670	2500	1
CV-22	57 FT 4 IN	9 FT 0 IN	3153	2081	3	271	81	300	652	670	2500	1
UH-1N	57 FT 3 IN	8 FT 0 IN	3092	2040	3	265	80	300	645	670	2500	1
C-38A	55 FT 7 IN	7 FT 2 IN	2955	1950	3	254	76	300	630	670	2500	1
A-10 & OA-10	53 FT 4 IN	5 FT 0 IN	2720	1795	3	233	70	300	603	670	2500	1
F-16C/D	49 FT 5 IN	5 FT 0 IN	2520	1663	3	216	65	300	581	670	2500	1
T-1A	48 FT 8 IN	5 FT 0 IN	2482	1638	3	213	64	300	577	670	2500	1
C-21A	48 FT 7 IN	4 FT 11 IN	2473	1631	3	212	64	300	576	670	2500	1
RQ-4A	48 FT 5 IN	4 FT 8 IN	2452	1619	3	210	63	300	574	670	2500	1
C-12	43 FT 9 IN	4 FT 6 IN	2209	1458	3	190	57	300	542	670	2500	1
F-35A/B/C	50 FT 8 IN	5 FT 0 IN	2584	1705	3	222	67	300	589	670	2500	1
F-15A/B/C/D	63 FT 9 IN	5 FT 0 IN	3389	2567	4	334	192	600	1125	1340	2500	1
F-15E	63 FT 9 IN	5 FT 0 IN	3389	2567	4	334	192	600	1125	1340	2500	1
F-117A	65 FT 11 IN	5 FT 0 IN	4021	2654	4	345	200	600	1145	1340	2500	1
F-22A	62 FT 1 IN	5 FT 0 IN	3787	2499	4	325	188	600	1113	1340	2500	1

NFPA Category 5 Airports by Aircraft Type	Fuselage Length	Fuselage Width	TCA Sq Ft L x (K+W)	PCA Sq Ft .66 x TCA	NFPA Airport Cat Table 4.3.1	NFPA Q-1 .13 x PCA x 1	NFPA Q-2 Q2% x Q1	NFPA Q-3 Table B.5.3	Total Q1+Q2+Q3 Gallonage Required	NFPA 403 Gallonage	AF ASC010 Gallonage	AF Vehicle Set
C-20A/B/C/H	83 FT 2 IN	7 FT 4 IN	8759.24	5781.1	5	751.54	563.65	1250	2563	2760	4000	2

NFPA Category 6 & 7 Airports by Aircraft Type	Fuselage Length	Fuselage Width	TCA Sq Ft L x (K+W)	PCA Sq Ft .66 x TCA	NFPA Airport Cat Table 4.3.1	NFPA Q-1 .13 x PCA x 1	NFPA Q-2 Q2% x Q1	NFPA Q-3 Table B.5.3	Total Q1+Q2+Q3 Gallonage Required	NFPA 403 Gallonage	AF ASC010 Gallonage	AF Vehicle Set
C-9A/C (DC-9)	119 FT 3 IN	10 FT 1 IN	12889	8506	6	1106	1106	1250	3462	3740	5000	3
C-40C (737)	110 FT 4 IN	11 FT 6 IN	11943	7883	6	1025	1025	1250	3299	3740	5000	3
EC-130E	100 FT 6 IN	10 FT 3 IN	10879	7180	6	933	933	1250	3117	3740	5000	3
T-43A (737) (Ret)	100 FT 0 IN	11 FT 6.5 IN	10954	7230	6	940	940	1250	3130	3740	5000	3
WC-130H	99 FT 4 IN	10 FT 3 IN	10752	7097	6	923	923	1250	3095	3740	5000	3
HC-130P/N	98 FT 9 IN	10 FT 3 IN	10690	7055	6	917	917	1250	3084	3740	5000	3
MC-130P	98 FT 9 IN	10 FT 3 IN	10690	7055	6	917	917	1250	3084	3740	5000	3
AC-130H/U	97 FT 9 IN	10 FT 3 IN	10581	6984	6	908	908	1250	3066	3740	5000	3
C-130 E/H/J/J-30	97 FT 9 IN	10 FT 3 IN	10581	6984	6	908	908	1250	3066	3740	5000	3
EC-130H	97 FT 9 IN	10 FT 3 IN	10581	6984	6	908	908	1250	3066	3740	5000	3
LC-130	97 FT 9 IN	10 FT 3 IN	10581	6984	6	908	908	1250	3066	3740	5000	3
MC-130E/H	97 FT 9 IN	10 FT 3 IN	10581	6984	6	908	908	1250	3066	3740	5000	3
C-37A	96 FT 5 IN	7 FT 4 IN	10155	6702	6	871	871	1250	2993	3740	5000	3
MH-53J/M	92 FT 9 IN	7 FT 6 IN	9785	6458	6	840	840	1250	2929	3740	5000	3
C-32A (757)	155 FT 3 IN	11 FT 4 IN	16973	11202	7	1456	1879	1250	4585	4880	5000	3
E-8C (707)	152 FT 11 IN	11 FT 8 IN	16768	11067	7	1439	1856	1250	4545	4880	5000	3
E-3B (707)	146 FT 6 IN	11 FT 8 IN	16065	10603	7	1378	1778	1250	4007	4880	5000	3
C-22B (727)	133 FT 2 IN	11 FT 4 IN	14558	9609	7	1249	1611	1250	4110	4880	5000	3
RC-135U/V/W (707)	140 FT 6 IN	11 FT 8 IN	15407	10169	7	1322	1705	1250	4277	4880	5000	3

NFPA Category 8 Airports by Aircraft Type	Fuselage Length	Fuselage Width	TCA Sq Ft L x (K+W)	PCA Sq Ft .66 x TCA	NFPA Airport Cat Table 4.3.1	NFPA Q-1 .13 x PCA x 1	NFPA Q-2 Q2% x Q1	NFPA Q-3 Table B.5.3	Total Q1+Q2+Q3 Gallonage Required	NFPA 403 Gallonage	AF ASC010 Gallonage	AF Vehicle Set
B-1B	146 FT 0 IN	10 FT 0 IN	15768	10407	7	1353	1745	1250	4348	4880	8000	4
B-2A	69 FT 0 IN	10 FT 0 IN	4554	3006	4	391	227	300	917	7780	8000	4
B-52G/H	158 FT 4 IN	12 FT 4 IN	17469	11529	7	1499	1933	1250	4682	7780	8000	4
KC-135 (707)	136 FT 3 IN	11 FT 2 IN	14873	9816	7	1276	1646	1250	4172	7780	8000	4
KC-46 (767)	159 FT 2 IN	16 FT 4 IN	18228	12030	7	1564	2017	1250	4831	4880	8000	4
C-17A	174 FT 0 IN	18 FT 0 IN	20184	13321	8	1732	2632	2500	6864	7780	8000	4

The aircraft highlighted in yellow above were moved to a higher airport category because of their fuel loads and the B-2's wing design.

NFPA Category 9 Aircraft by Aircraft Type	Fuselage Length	Fuselage Width	TCA Sq Ft L x (K+W)	PCA Sq Ft .66 x TCA	NFPA Airport Cat Table 4.3.1	NFPA Q-1 .13 x PCA x 1	NFPA Q-2 Q2% x Q1	NFPA Q-3 Table B.5.3	Total Q1+Q2+Q3 Gallonage Required	NFPA 403 Gallonage	AF ASC010 Gallonage	AF Vehicle Set
KC-10A (DC-10)	181 FT 7 IN	19 FT 9 IN	21381	14111	8	1834	2788	2500	7123	7780	10000	5
E-4B (747)	231 FT 4 IN	11 FT 6.5 IN	25340	16724	9	2174	3696	2500	8370	9570	10000	5
VC-25 (747)	231 FT 10 IN	20 FT 2 IN	27161	17926	9	2330	3962	2500	8792	9570	10000	5

The KC-10A aircraft highlighted in yellow was moved to a higher airport category because of its fuel load.

NFPA Category 10 Aircraft by Aircraft Type	Fuselage Length	Fuselage Width	TCA Sq Ft L x (K+W)	PCA Sq Ft .66 x TCA	NFPA Airport Cat Table 4.3.1	NFPA Q-1 .13 x PCA x 1	NFPA Q-2 Q2% x Q1	NFPA Q-3 Table B.5.3	Total Q1+Q2+Q3 Gallonage Required	NFPA 403 Gallonage	AF ASC010 Gallonage	AF Vehicle Set
C-5A/B/M	247 FT 10 IN	23 FT 9 IN	30173	19914	10	2589	4919	5000	12626	12626	13000	6

RECOMMENDATIONS AND BEST PRACTICES FOR IMPLEMENTING A SIMULATED AIRCRAFT ACCIDENT AND EMERGENCY RESPONSE DRILL DURING A REHEARSAL SHOW

30 DAYS OUT

- ARFF personnel will be notified that emergency response drill (ERD) will be conducted during rehearsal show (typically held on Friday at most weekend shows).

UPON AIR BOSS ARRIVAL AT SHOW VENUE

- Air boss, (air traffic control (ATC) if applicable, airport director (AD) if necessary) and waiver holder meet with ARFF and discuss rules of engagement (ROE) for ERD.

- Air boss should discuss how long the ERD will take and how long it will take for ARFF to recover back into their positions following the drill. Plan the sequence accordingly. (For example, if the air boss determines that the drill itself will take 20 minutes and ARFF will take another ten minutes to return to position, then air boss should build a 30-minute slot into schedule for the rehearsal show.)

REHEARSAL DAY PERFORMER BRIEFING

- Air boss will inform everyone that an ERD will take place and review ROE, but will not issue specifics as to the time and location of drill.

- Air boss will have a private conversation with performers scheduled to perform prior to and after ERD is to take place for situational awareness. ATC considerations, particularly at 139 airports with 121 ops.

GENERAL OBSERVATIONS AND POTENTIAL RULES OF ENGAGEMENT

- No water or foam will be used during this drill. (To save time for refuel and minimize the risk of anything being damaged by the use of high pressure water or foam.)

- ERD is not to be commenced in the middle of a performer's routine. The performer needs to run through an uninterrupted sequence.

- Do not use a performer aircraft to simulate an emergency aircraft (To ensure that a helpful and important drill does not become the cause of damage to a performer's aircraft).

- The emphasis of the drill will be on 1) communications between ARFF crews, air boss and ATC; 2) ARFF crews leaving their ready position(s) and traveling as quickly as possible to emergency site; and 3) ARFF personnel arriving at the emergency site and announcing their availability to engage with fire suppression, emergency extraction, etc.

- At the start of ERD, air show announcer will state that this is a drill and repeat that announcement through the drill so to keep those onsite and the media from being alarmed.

AT CONCLUSION OF DRILL

- Verify all ARFF units are in back in ready positions on flight line and ready to recommence show.

- If ARFF team does not roll within 10 seconds or reaches the incident scene ready to engage within 60 seconds, air boss and ARFF must debrief what went wrong and determine ways to adjust and be within industry standards prior to the next show day. This should be done even if the team does make the goal, but there is consensus that they could have done better. Air boss, waiver holder, ARFF, ATC and AD should be in agreement.

POTENTIAL MEDIA IMPACTS

With rehearsal days typically also serving as media day, these drills are likely to draw media attention to the potential of an accident and the topic of air show safety. Event organizers should have talking points ready, with

emphasis on the drill being just one part of the air show's commitment to and preparation for being ready for a wide variety of possible incidents. Because the topic often comes up with the press anyway, the drill will provide event organizers with an opportunity to discuss emergency planning frankly. ICAS will make available a sample list of talking points for interaction with media on this issue.