Pyrotechnics and Special Effects for Air Shows

4th Edition

By

Gordon Webb
Chair, ICAS Pyro Safety Subcommittee and TORA TORA TORA

April Zalesky
ICAS Pyro Safety Subcommittee and AV8FX

David Linebarger
ICAS Pyro Safety Subcommittee and CAF Blastards

Rodney Robinson
ICAS Pyro Safety Subcommittee and CAF EOD

Roger Crawford
ICAS Pyro Safety Subcommittee and Airshow SpecialFX

AN ICAS PUBLICATION

INTRODUCTION

The ICAS publication, “Pyrotechnics and Special Effects for Air Shows, 4th Edition,” is a planning aid and contains the guidelines and standards recommended by the International Council of Air Shows (ICAS). This publication is in no way intended to address all the eventualities when planning for the pyrotechnic and special effects that may be incorporated into the event. The materials generally used are highly explosive and extremely flammable. All local, state/provincial and federal laws must be adhered to. Some laws in some areas could be more restrictive than the recommendations contained herein. It is imperative that your special effects activities have the required approvals from your local authorities. Your planning efforts and decisions must be based on the specific circumstances which exist and cannot be determined by a general manual such as this.

While this publication may help you in the specific activities for special effects at your event, your use of this publication and any other materials or advice from the International Council of Air Shows, Inc. or its agents signifies your agreement with ICAS that:

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The International Council of Airshows (ICAS)
748 Miller Drive, SE. Suite G-3
Leesburg, Virginia 20175
703-779-8510

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CHAPTER 1 – EXECUTIVE SUMMARY OF GUIDELINES

The ICAS Pyro Safety Manual is a compilation of the latest research and regulation regarding the use of special explosive effects at airshows throughout North America. These guidelines are generally detailed and, where appropriate, technical in their presentation. However, in an effort to make this material more "user friendly" and convenient, we have chosen to begin the manual with an executive summary of this material organized by the categories of primary airshow responsibilities.

This chapter presents a summary of the more salient portions of the guidelines, broken down by the following categories:

1. Guidelines of Concern to Organizers/Promoters
2. Guidelines of Concern to Contractors/Shooters in Charge
3. Guidelines of Concern to Pilots and Performers
4. Guidelines of Concern to the Airboss
5. Guidelines of Concern to Fire and Safety Personnel
6. Guidelines of Concern to Airport Grounds Supervisors

These summaries are NOT a substitute for reviewing and understanding the full text of the material. Rather, they are designed as a convenient way to help the various elements mentioned above to know the issues they must deal with and serve as reminders of the items to pay attention to. Review of these summaries should not be considered "sufficient" reading and they do NOT provide sufficient detail to ensure SAFETY.

A. A Summary of ICAS Pyrotechnic Safety Guidelines of Concern to Show Promoters and Organizers

Special effects explosives work at airshows requires special training and knowledge. This training and knowledge cannot be gained simply by the commercial application of explosives in quarrying, mining, or construction, nor by the casual use of explosives in an agricultural environment, nor through military explosives training. Airshow special effects explosives use requires careful research, testing, training, and experience specifically on the use of these materials for special effects purposes in an AIRSHOW ENVIRONMENT. Consequently, promoters/organizers should employ only contractors meeting minimum requirements suggested by ICAS for airshow Pyro/Special Effects contractors.

The air show sponsor should meet with the local airport authorities and Fire Marshall at least 120 days prior to the event to determine the exact requirements which have to be met.

Pyro/Special Effects activities should be limited when: 1.) extreme ground space limitations exist, 2.) the intended site is too close to the crowd (Less than 500 foot distance), and 3.) noise sensitivities exist in the local area.

Do some basic research and check the reputation of the proposed Pyro/Special Effects contractor before making a decision to hire them. Require and check references.

Expect the contractor to present proof of a current, in force, paid up insurance policy with specific reference to pyrotechnic liability at airshows or have a written agreement to add the contractor as a "rider" on the show's policy. You will want to discuss the use of pyro/special effects at your event with your insurance carrier and legal counsel and require coverage as may be recommended or desired.

Your special effects plan should be discussed with the contractor at least 120 days in advance so that the proper amount of supplies can be ordered for the show. Some supplies may have to be special ordered and need a minimum of 120 days to arrive.

Designate one person as the primary local point of contact for the pyro/special effects contractor. This person should be available during the entire show weekend, including all day Thursday and Friday prior to the show

Have the contractor provide you with the name and contact information for the "Shooter In Charge" (SIC) being assigned to your airshow. Work with the SIC to

obtain all necessary permits required by local authorities. These permits should be current, valid, and issued specifically in the SIC's/Airshow's name.

Ensure a Notice to Airmen (NOTAM) has been issued if the pyro/special effects area is being set up prior to the waiver. Non-participating aircraft need to know, for example, that "air show special effects pyrotechnics are being installed 400 feet north of Runway 9-27 from 0800 until 1100."

Ensure that there is a reliable radio communications network established between the pyro/special effects team, the air boss, fire department, security officials, paramedics and any other persons who may be needed to coordinate the desired effects or in the event of an emergency situation in the area.

Event sponsors must ensure reliable fire support from the local fire department. If the fire support specified by the contractor and required to ensure safe detonation of pyro/special effects explosions is not provided by the event sponsor, the "Shooter in Charge" is within his or her rights to refuse to detonate explosive effects. In this case, the event sponsor is still liable for payment of the contractor.

During all show days, the fire department should be put on "stand-by" status, readily accessible to the pyro site. Standby status requires the fire department to be on site, stationed on the "show side" of the crowd line, with a sufficient supply of water, and pre-coordinated with the SIC.

Make prior arrangements to strictly enforce all FAA and other aviation related regulations regarding: proper operations on aprons, taxiways, runways, radio procedure, aircraft identification, runway safety zones, air show and performer etiquette, as well as all provision of the "waiver" with respect to pyrotechnic operations.

Require the participation of the Pyro/Special Effects contractor in all airshow performer briefings.

Designate and properly prepare the pyro/special effects area:

1. Location– preferably show center, 500 to 1200 feet from the crowd line depending upon the type acts used (high speed, low speed, etc.).
2. Accessible to fuel trucks.
3. There should be a firebreak at least 50 feet wide between the spectator area and the pyro area.
4. The pyro area should be free of airport equipment or other items that may be sensitive to explosives. Its location should be determined with the help of the airport manager, considering runway safety zones, clearways, etc

5. Size of the area – the prepared area (burned or cleared) should be at least 100 feet larger on all sides than the area required for actual explosives setup.
6. The pyro/special effects area must have adequate security to prevent spectators or other personnel from entering the area. Promoters are responsible for controlling access to the field by non-contractor related personnel.
7. If grass and other vegetation are present, they should be burned off the week prior to the show. This is very important and should be done to preclude uncontrolled fires that could cause uncontrolled detonations during acts using special effects support. If it is not practical to burn off the area, any vegetation should be cut as short as possible and removed from the area. This includes picking up and removal of grass clippings. Consider scraping the area clean of vegetation using a construction grader. Controlled pre-burning is the method of choice and results in less long-term harm to the property than scraping. If cutting is used, removal of cut vegetation by the promoter from the pyro/special effects area is essential.

Provide the contractor with a safe and efficient means of dispensing fuel, specifically, a vehicle or truck equipped with a metered dispensing system similar to that used for over-wing fueling of aircraft or construction equipment. Fifty-five gallon drums are an EXTREMELY dangerous method of dispensing fuel. Use of 55-gallon drums to dispense fuel should be avoided. UNDER NO CONDITIONS SHOULD STEEL DRUMS BE ALLOWED. Steel drums, when loaded in pickup trucks, may spark against themselves in transport or between the bed or sides of the pickup truck. Empty drums are even more hazardous than full drums**.** Make sure fuel arrives at the area at the agreed upon time so as not to delay the acts supported by your pyro/special effects contractor.

If possible, coordinate a "crash/fire/rescue" simulation/rehearsal at least 1 day prior to the start of the show. Include reference to the pyro area in this simulation and thoroughly brief all CFR personnel on appropriate procedures as specified in the full manual.

Have the local "point of contact" or other appropriate airport personnel participate in an "area clearing walk-around" with the SIC at the conclusion of the show. The primary purpose of this "walk-around" is to ensure that all explosives materials have been expended or accounted for and that leftover materials are being removed from the site by proper transportation.

B. A Summary of ICAS Pyrotechnic Safety Guidelines of Concern to Pyro/Special Effects Contractors/SICs

The special effects explosives contractor should have a working knowledge of, and demonstrate compliance with, the applicable sections of local codes and ordinances pertaining to explosive materials, specific state codes and regulations pertaining to explosive materials, ATF regulations, National Fire Protection Association (NFPA) codes, Institute of Makers of Explosives Safety Library Publications, and manufacturer's recommendations for "Prevention of Accidents in the Use of Explosive Materials"

The contractor should ensure proper preparation of the Pyro/Special Effects by the promoter/organizer. Specifically, if grass and other vegetation are present, they should be burned off the week prior to the show. If it is not practical to burn off the area, any vegetation should be cut as short as possible and removed from the area. This includes picking up and removal of grass clippings. Consider scraping the area clean of vegetation using a construction grader. Controlled pre-burning is the method of choice. If cutting is used, removal of cut vegetation by the promoter from the pyro/special effects area is essential.

The contractor should identify a "Shooter in Charge" (SIC) for each specific airshow contract. In many cases, the contractor himself/herself will serve as the SIC. To be qualified as an SIC an individual should:

a. Possess a Federal ATF permit as a "permanent user of explosives material". An ATF permit for a "limited user" should not be viewed as sufficient for qualification as an SIC.
b. Have a minimum of 3 years "apprentice experience" under a qualified SIC, working with special effects explosives at airshows having actually worked with the set-up and shooting of special effects explosives at a total of at least 20 airshows.
c. Be thoroughly trained in all FAA and other aviation related regulations. Such knowledge can only be gained by either having private, military, or commercial pilot experience or through direct hands on experience and training under a currently qualified SIC.

The SIC should:

a. Communicate with all relevant airport and airshow personnel, as well as with any necessary federal, state/provincial, or local officials, prior to the first day of actual performance shooting at the airshow.
b. Receive and sign for all shipments of explosive materials to the site.
c. Be responsible for the storage of all explosive materials on site in accordance with appropriate federal, state/provincial, and local regulations.
d. Have in his/her possession at all times at the airport, a fully functioning, FAA approved aircraft band, tuned to the appropriate frequency (ies).

e. Ensure that all pyro personnel are equipped with and using appropriate safety equipment.
f. Meet with assigned fire-fighting personnel and pre-coordinate a plan for dealing with fires.
g. Attend every airshow briefing with other performers.
h. Develop, coordinate, and communicate an emergency plan for rendering harmless explosives and the pyro field in the event Crash/Fire/Rescue (CFR) personnel must be dispatched during the airshow.
i. Hold daily safety and information briefings with all personnel assigned to be present in the pyro field.
j. Ensure all movements of pyro personnel on aprons, taxiways, and runways comply with the standards of the airport involved.
k. Enforce all runway and taxiway safety zones.
l. Demonstrate knowledge of, comply with, and enforce all twenty-four (24) "General Safety Standards" enumerated on pages 13, 14 and 15 of the ICAS pyro safety manual[1].
m. Limit the number of personnel in the pyro/special effects area to the recommendations specified on pages 13 and 14 of the ICAS pyro safety manual[1].
n. Provide some method to fight grass fires. In addition, the fire department shall be put on “stand-by” status, readily accessible to the pyro site. Standby status requires the fire department to be on site, stationed on the "show side" of the crowd line, with a sufficient supply of water, and pre-coordinated with the SIC.
o. Determine whether or not environmental conditions, including wind speeds and direction, allow for the safe detonation of an explosive effect using as a guideline the recommendations found on pages 18 and 19 of the ICAS pyro safety manual[1].
p. Supervise the removal of objects such as rocks, cans, bottles, broken pieces of asphalt, etc. from the immediate vicinity of any explosive effect during setup.
q. Elevate explosives off the ground in such a way that any projectiles are blown in a direction away from the crowd, parked aircraft, and pyro-technicians.
r. Set up explosive effects no closer than 500 feet from the closest point of the crowd line or any parked aircraft. If the geographic and physical location dictates, and if the SIC determines it is both prudent and safe to set up explosive effects closer than 500 feet (close quarter effects), the maximum possible distance should be maintained, and pyro/special effects explosives detonated only if the following conditions are met:
    1. No close quarter effect should use more than 1.25 pounds of explosives total per delay.
    2. Rocks and other shrapnel producing material should be completely removed from the area. In the event of rocky soil, close quarter effects are discouraged.

3. Shrapnel and/or "FOD" producing materials used in the construction of the effect should be held to a minimum.
4. All blasting caps used in close quarter effects should be covered with soft stemming material (such as grass or dirt) sufficient to suppress the shrapnel from these objects.

s. Avoid placing actual explosive effects directly on the 500' line if practical.
t. Participate in an "area clearing walk-around" with airshow/airport personnel at the conclusion of the show to ensure that all explosives materials have been expended or accounted for.

In designing explosive effects, contractors should adhere to the following as a set of guidelines for minimizing the potential for property damage and broken glass from "airblast" effects of airshow pyro/special effects explosives.

1. Under most circumstances, no airshow pyro/special effects explosion should contain more explosives than the equivalent of 20 pounds of TNT total per delay.
2. In calculating poundage, both the pounds of powder used **and** the quantity of explosives contained in the prima cord should be included in the calculation. For example, 50-grain cord contains 50 grains of explosives per foot. In a 1000-foot roll of cord, you would have 50,000 grains of explosive. 7000 grains of explosive is equal to 1 pound, therefore in a 1000-foot roll of 50-grain cord you would have approximately 7 pounds of explosive (50,000 grains per roll divided by 7000 grains per pound).
3. Minimum delay times of not less than 25 milliseconds should be used in Pyro/special effects explosives containing more than 20 total pounds of explosives in such a way as to distribute the poundage to no more than 20 pounds per delay.
4. Since temperature inversions are likely to magnify airblast effects and are statistically more likely both one hour after sunrise and one hour before sunset, special effects explosions using more than 20 pounds of explosive (even if suppressed and/or delayed) should be avoided during these periods if possible.
5. The maximum poundage per delay may be modified either up or down by the SIC if conditions such as cloud cover, environmental factors, or location/terrain considerations warrant doing so.

The Contractor should provide at least one, preferably more, fully charged and properly functioning, 10-pound fire extinguisher approved for use on fuel fires. These extinguishers should be readily available during all fueling operations. Extinguishers should be close at hand, up wind, and not stored in the rear of the pickup truck or the fuel truck during fueling operations. At least one person should be familiar with their proper operation and effective use.

C. A Summary of ICAS Pyrotechnic Safety Issues of Concern to Performers

Don't handle or use any materials you are not licensed and trained to use.

Insist that your materials are stored at a secure, remote site at the event and in compliance with all federal, state/provincial and local regulations.

Let the event sponsor know if you are shipping material so they can watch for its arrival and store it properly.

Do not fly over the crowd or closer than 500' to the crowd when you have a load of pyro on board other than wing-tip smoke. When conditions warrant, increase this minimum distance to the crowd to account for wind drift of airborne pyrotechnics

Keep the pyro firing system shunted/safed (electrically "dead") until airborne. Make sure the firing system can be shut down in flight in the event of an emergency.

Ground your aircraft while setting up pyro.

Load and set up your pyro outdoors in remote area, away from spectators, buildings and fuel storage areas. This remote area should be at least 500' from the nearest point of the crowd or other aircraft and at least 1500' from the nearest fueling operation or fuel storage location

Fuel your aircraft before going to the remote pyro area to load and set up. Do not fuel in the remote area.

Do a safety check and unload any unexpended pyro in the remote area immediately after your performance.

Consider the effect of winds and altitude on the fallout and residue from burning pyro. Sparks and/or burning debris should never reach the ground or spectator areas.

Consider whether electrical storms, static electricity or radio transmissions can disturb your firing mechanisms.

Be aware of the potential effects of pyro on night vision and the possibility of night vertigo. Talk to other performers about their experiences and solutions.

Brief the CFR crew on what materials are on board your aircraft. In the event of an emergency, they must be prepared to deal with the possibility of live pyro materials.

Have CFR crew on standby during all loading/unloading operations.

Coordinate your use of airborne pyro with the ground based pyro/special effects contractor prior to the start of the show so that everyone knows what to expect and what precautions might be necessary for safety considerations on the part of ground based pyrotechnicians and their supplies.

For aircraft participating in the use of ground based pyro, it is recommended that aircraft do not directly overfly the pyro area, but stay behind it by 150 feet with a minimum altitude of 200 feet. Lower altitudes may be allowed if practiced and/or defined by the performer's approved maneuvers package. If this guideline is observed, aircraft would not be directly overhead in the event of an errant detonation.

In addition to the above recommended offset of the flight path from the pyro area, normal timing of the simulated dropping of ordnance would dictate that the aircraft continue past the area prior to detonating explosives. Rocket or Strafing Passes passes differ from bomb or napalm-type passes in that the pyrotechnic event will happen in front of the aircraft. These passes need to be specifically coordinated with all pilots involved to assure they are expecting pyro/special effects in front of them.

CHAPTER 2 – INTRODUCTION AND OVERVIEW

The goal of putting this material together is to create a "living" reference source that may be updated as regulations and procedures change or as new knowledge is gained. In 1998, ICAS published the first edition of these guidelines. Since that time, world events have made adherence to safety and security issues even more imperative.

This reference source is intended to be used by air show performers, sponsors, and producers for information and guidance on the many requirements that may have to be met when explosives, special effects and pyrotechnics/special effects are introduced into the air show environment. This manual is designed to address safety issues with respect to the three categories of airshow pyrotechnics: Ground based pyrotechnics, Fireworks, and Airborne pyrotechnics. In addition to this manual, the NFPA has excellent materials on the storage and use of explosives and fireworks.

All persons associated with pyrotechnics/special effects should understand that they are regulated by various Local, State, Provincial, and Federal governmental agencies as "Dangerous Goods," in Canada, or as "Hazardous Materials" in the United States. Generally speaking, the rules regarding Hazardous Materials can be broken down into four categories: Manufacture, Transportation, Storage, and Use. It is the last three areas that are normally of concern to air shows and performers.

TRANSPORTATION – In the U.S., the Department of Transportation has almost 100% responsibility for rules applying to transportation of all hazardous materials by any mode (air, highway, rail, and water). Various agencies have responsibility for enforcing these transportation rules including the FAA and the Federal Highway Administration. Natural Resources Canada, Explosives Regulatory Division, regulates both transport and storage in Canada

STORAGE requirements are usually a combination of local, state/provincial and federal regulations. Most all state/provincial and local regulations closely parallel the federal regulations of the Bureau of Alcohol, Tobacco, Firearms, and Explosives (BATF&E) and of Natural Resources Canada. These regulations are spelled out very clearly in ATF Publications P5400.7 and in the equivalent Canadian regulations.

USE of pyrotechnic and explosive materials is regulated primarily by the state/provincial or local authorities. Depending on the type of materials, the ATF may also have regulations which apply.

It is virtually impossible to identify the single most important person that can help you through this maze of regulations in each state/province. In some states/provinces, the local Fire Marshall has jurisdiction for the air show site.

However, local Fire Marshall's may have very little training in explosives and pyrotechnics. Some states/provinces have State or Provincial Fire Marshall's offices with personnel trained in the regulation of explosives. In other states, explosive regulation is assigned to the State Bureau of Investigation or the State Police. The easiest way to find out the appropriate regulating agency is to contact the local office of the Bureau of Alcohol, Tobacco, Firearms and Explosives or Natural Resources Canada. Every state/province has at least one ATF or BNRC office. If state and/or local officials are approached EARLY in the planning stages of the show and made aware of what your needs are, they will be only too glad to help you. After all, their goals are the same as yours – Safety to the Public.

Prior to contacting state/provincial or local officials, you will want the following information:

1. A list from ALL performers (pilots, skydivers, pyrotechnics, jet cars, etc.) who plan on using ANY pyro or explosive materials, of all the hazardous materials that they will be shipping, bringing, or having delivered to the air show site (even if they are not going to be using those pyrotechnic materials at that specific site);

2. Name, address, and telephone number of shipper;

3. Proper shipping name;

4. Hazard class or division

5. Subsidiary risks, if any;

6. Total Quantity (net explosive weight or NEW);

7. Date materials will arrive at the show site;

8. Storage arrangements on site;

9. Date materials will be used/depart show site.

10. A 24 hour emergency contact phone number for the pyro contractor, or performer.

The definition of ground based pyrotechnics or special effects as used in this manual is explosive materials and/or fuel detonated to represent mock bombings, strafing runs, napalm, etc.

Terminology – The company names of contractors that regularly service the air show industry include pyro, bomber, special effects. The terms mean different things to different people. For the purpose of consistency in these guidelines, the term pyro/special effects will be used as it reflects the terminology most commonly used within the air show industry.

The manufacture, transportation, storage, and use of explosive materials are regulated by many local, state/provincial and federal agencies. Regulations are very clear about what is required for compliance. No special provisions or considerations are made for air shows. In an air show environment, it is the use of these materials for theatrical purposes to create visual and audible effects in conjunction with aircraft flying displays that requires all participants in the activity to be aware of the applicable regulations and ensure compliance by all contractors.

The types of materials required to produce most air show special effects will usually be more volatile than consumer or display fireworks. Most materials used by contractors will be class 1.1 explosives. These types of materials have the strictest regulations regarding transportation, storage and use. Your local Fire Marshall will be concerned about their proper storage and transportation. Make sure you, your representative or your contractor meet with him/her early on about these materials.

The procedures contained in this manual represent the minimum acceptable safety procedures that should be observed by those responsible for pyro/special effect operations at air shows. No set of procedures can anticipate all situations which may be encountered. Consequently, no one may assume safe operations by merely or blindly following these guidelines.

No standards will ever exist which can substitute for common sense, sound judgment, and a continuing concern for maximum safety. **Safety is a state of mind.**

Finally, it is important to understand that the success and safety of the ground pyrotechnic/special effects portion of an air show is dependent upon the following groups of people working closely together:

Event Organizer
Pyro/Special Effects Contractor
Pilots

Air Operations Coordinator/Air Boss
Airport Manager
FAA Monitors
State/Provincial and Local Fire and Explosives Officials

CHAPTER 3 – THE AIRSHOW ORGANIZER/PROMOTER'S ROLE AND GUIDELINES

The following items are the essential responsibilities of the air show organizer/promoter. It is critical that event organizers spend time addressing each of the following concerns well in advance of the actual show. Most of these issues will require involvement from you pyro contractor in order to plan and answer the issues sufficiently.

A. WHAT EVENT ORGANIZERS NEED TO KNOW

PYRO / SPECIAL EFFECTS ARE DIFFERENT!!!
Pyro/Special Effects need different permits, different regulatory agencies, have unusual operational needs, have a far reaching and different impact on the operations of your show than aircraft acts. Assignment of a dedicated "Project Manager" is highly recommended.

Hire only airshow experienced and recognized pyro/special effects contractors. Do you want someone with no airshow experience mixing explosions with aircraft at your show?

1. Reasons to include pyro/special effects in your event:

    a. To enhance modern military aircraft demonstrations
    b. To enhance modern military ground force assaults
    c. To enhance "warbird" aircraft or other civilian demonstrations
    d. To enhance night shows with "warbird" aircraft
    e. As a stand-alone night show act
    f. To add entertainment value for spectators
    g. To add more realism to the air show
    h. To bring spectators inside the gate that might otherwise watch from outside

2. When to limit pyro/special effects activities:

    a. When extreme ground space limitations exist
    b. When the intended site is too close to the crowd (Less than the recommended minimum 500 foot distance discussed below)
    c. When noise sensitivities exist in the local area, like schools/hospitals/nursing homes that are in close proximity to the airfield and/or when the activity may aggravate relationships between airport officials/local community leaders/airport neighbors and tenants.

3. Before an air show uses pyro/special effects for the first time:

The air show sponsor should meet with the local airport authorities and Fire Marshall at least 180 days prior to the event to determine the exact requirements which have to be met. The first time around, these requirements may seem overwhelming and burdensome. But to experienced contractors, they are usually routine. Typical questions and requirements that will be discussed include:

a. Proper insurance
b. Site location, size and plan showing location of pyro area relative to persons/property
c. Storage and transportation of explosives
d. Qualifications of contractor
e. Emergency procedures
f. Fire control
g. Distance from spectators
h. Number, type and size of effects that will be produced
i. Show schedule showing times of pyrotechnic/special effects events

4. Items to consider when planning to use special effects:

a. Will formation passes be used?
b. How many passes will each aircraft/formation make?
c. From which direction?
d. Have or will ALL involved pilots been briefed?
e. What is the desired effect?
    Single or multiple explosions, strafing, wall of fire?
    Which direction/Which pass?
f. Will there be more than one act requiring pyro/special effects?
g. How much time will your contractor require between acts scheduled for effects?
h. Is a U.S. military jet team performing at your show? U.S. military jet teams have requirements that impact on the pyro team. U.S. jet teams require that all personnel leave the pyro/special effects area (sterile box) during their practice or performance, taking time away from the pyro team's set-up schedule. Also it may take the pyro team (and fire trucks) as long as 45 minutes to safety the pyro area after pyro acts. Allow for this in your scheduling of U.S. jet teams. U.S. jet teams may want runways/taxiways swept if they perform after the acts with pyro/special effects support. Avoid last-minute problems by discussing these considerations with your contractor.
i. The show organizer and contractor must consider CONFLICTING USE OF THE PYRO/SPECIAL EFFECTS AREA. Helicopters and Harrier demonstrations hovering over or landing in a live pyro/special effects area must be prohibited when planning show schedules. Other items to consider are "ribbon cut pole holders" skydivers, glider landings, ground assault troops, etc., that may also be planning to use or transit

the proposed pyro/special effects area. These activities can be accommodated safely with proper scheduling.

NOTE: Your special effects plan should be discussed with the contractor at least 180 days in advance so that the proper amount of supplies can be ordered for the show. Some supplies may have to be special ordered and need a minimum of 120 days to arrive.

Requests for additional special effects support that are added after the supplies are purchased can “water down” the show’s desired effect.

5. The Local Point of Contact (POC)/Project Manager

Once a show decides to incorporate special effects in the event program, it is crucial that one person be designated as the primary point of contact for the pyro/special effects contractor. This person should be available during the entire show weekend, including all day Thursday and Friday prior to the show. He/she should not be heavily committed to other air show responsibilities.

The POC will be expected to acquire local permits if necessary. The SIC will assist the POC and provide information as needed for the permits.

The POC will be expected to assist the contractor in the following areas:

a. Inspecting proposed pyro/special effects area(s)
b. Briefing local airport, fire or police personnel about air show pyro/special effects plans
c. Assisting, when requested by the contractor, in locating proper storage facilities
d. Briefing local Crash/Fire/Rescue (CFR) personnel and other officials about safe transit through or around pyro/special effects areas
e. Coordinating with airport authorities regarding the location and access to the area
f. Scheduling meeting(s) with the contractor and all concerned local officials (air show, fuel, fire, police, airport authorities, etc.) prior to show dates
g. Helping to troubleshoot unexpected local problems as they arise
h. Coordinating security needs for the area
i. Securing qualified escorts for the contractor while working in secured areas of the airport

6. ISSUE A NOTAM:

Ensure a Notice to Airmen (NOTAM) has been issued if the pyro/special effects area is being set up prior to the waiver. Non-participating aircraft need to know, for example, that “air show special effects pyrotechnics are being installed 400 feet north of Runway 9-27 from 0800 until 1100.”

7. Event sponsors must ensure that there is a reliable radio communications network established between the pyro/special effects team, the air boss, fire department, security officials, paramedics and any other persons who may be needed to coordinate the desired effects or in the event of an emergency situation in the area.

8. Event sponsors must ensure reliable fire support from the local fire department. If the fire support specified by the contractor and required to ensure safe detonation of pyro/special effects explosions is not provided by the event sponsor, the "Shooter in Charge" is within his or her rights to refuse to detonate explosive effects. In this case, the event sponsor is still liable for payment of the contractor.

9. Event Sponsors must properly prepare the pyro/special effects area

   Not pre-burning or otherwise removing vegetation from the pyro area is the single biggest problem for pyro/special effects contractors at show sites. Burning vegetation with even moderate winds can create an “out of control” grass fire that can stop or delay your show while fires are being brought under control.

   Smoke from grass fires can shut down a runway, cause fuel critical aircraft to divert, or choke out the VIP Chalet.

   As much vegetation as possible should be removed from the pyro area and surrounding “safety perimeter”

   The best time to pre-burn is usually about two weeks before the show. This allows the dust and ashes to settle. At a minimum the pre-burn should be at least one week prior to the show.

   Check with your contractor – make sure the area is large enough!

   Don’t plan car or aircraft parking immediately downwind or adjacent to the pyro area.

   a. The area should be well designed and the use of special effects must be well coordinated.
   b. Location– preferably show center, 500 to 1200 feet from the crowd line depending upon the type acts used (high speed, low

speed, etc.). Remember, high speed acts can move in to the 500 foot line if they are non-aerobatic passes. (in the U.S.)

c. The area must also be accessible to fuel trucks. This area should not be swampy, have deep ditches or other obstacles which may prevent the operation of a 1,000 gallon fuel truck in the area.
d. There should be a firebreak between the spectator area and the pyro area. This already may be in existence, such as a runway, taxiway, road or tarmac. If no such firebreak exists, it is highly recommended that one be plowed or disked into the soil. It should be at least 50 feet wide.
e. The pyro area should be free of airport equipment or other items that may be sensitive to explosives. Its location should be determined with the help of the airport manager, considering runway safety zones, clearways, etc.
f. Size of the area – this will vary depending upon the size of the show and number of acts scheduled for special effects support. Ask your contractor what his/her requirements will be. However, national recommendations for minimizing the risk of brush fires suggest that the prepared area (burned or cleared) should be at least 100 feet larger on all sides than the area required for actual explosives setup. In other words, if the pyro contractor requires an area 1500 feet long and 500 feet wide, the event sponsor should prepare an area 1700 feet long by 700 feet wide. The contractor should not infringe into the 100 foot perimeter, but it is permissible for this perimeter to be part of the "runway safety zone"
g. Security – The pyro/special effects area must have adequate security to prevent spectators or other personnel from entering the area. This is critical at night shows when it may not be possible to see intruders in the area.
h. Storage – Your pyro/special effects contractor will be required to locate and use storage areas and transportation that comply with local, state/provincial and/or federal laws. Supplies are considered hazardous materials and may not be kept or stored in crowded/populated areas, hotel rooms, etc. Normally, the local Fire Marshall or Police Chief will be knowledgeable about safe locations for such materials. If they cannot help, a local quarry, construction or excavation company may have access to approved storage facilities, boxes or magazines. Safe storage of explosive materials is very important and is required by law. Be sure to discuss these matters with your pyro/special effects contractor.
i. Setup – It takes a considerable amount of time for the pyro/special effects contractor to set up on show days. As much as eight hours may be required depending on the size of

the show, weather conditions, site conditions, availability and accessibility of fuel to the area, Jet Team schedules, last minute changes by show sponsors, volunteers availability, etc. Make sure the contractor can access the airfield and the area in the early morning along with volunteers, assistants, fuel, and supplies.

10. Event Sponsors must ensure compliance with all provisions of FAA Chapter 49 (Change 22), Section 15, Paragraph K, regarding pyrotechnic displays and waiver requirements. In Canada, the corresponding reference material may be found in CARs Part 6, Div. 1, Sec. 623. These issues should be discussed and reviewed with your pyro contractor, your airboss, and airport authorities.
11. The FAA has "Special Provisions" incorporated into the Airshow Waiver regarding the placement on the airport of pyro/special effects and also requirements that must be met at the daily pilot briefing.
12. The pyro/special effects team has the same "human needs" as any other person. Have arrangements been made for PLENTY of drinking water, ice and lunches. Is a Port-a-Pot available to them? If every person has to cross an active runway and return to take care of these needs, it will become a burden on the tower/airboss. Remember the pyro/special effects are being set up in the "sterile box"

B. WHAT YOU SHOULD EXPECT FROM SPECIAL EFFECTS/PYRO CONTRACTORS

The contractor must be held accountable for the safe conduct of explosive operations. The Air Operations Director will be informed when the explosive operations are to be conducted and ensure that all participants in the event are properly briefed on the activities and how they may or may not affect their participation. Your contractor must ensure that safety is never jeopardized.

The contractor is responsible to ensure that the following standards are followed:

1. Explosive operations are conducted in accordance with current local, state, provincial and Federal regulations.
2. Explosive operations are conducted in a safe and suitable location.
3. Explosives are stored in a safe location.
4. Supplies and equipment for a safe operation have been provided and are in use.
5. Supplies and equipment used meet required standards.
6. The contractor should present the show promoter with proof of a current, in force, paid up insurance policy with specific reference to pyrotechnic liability at airshows. Promoters will want to discuss the

use of pyro/special effects at your event with your insurance carrier and legal counsel and require coverage as may be recommended or desired.

The best method a promoter can use to select a pyro/special effects contractor is to do some basic research and check references. Specifically:

1. Travel to other air shows and view the work of different pyro/special effects contractors.
2. Ask your prospective contractor for a list of airshow references and check them out with other event organizers and performers.
3. Ask other airshow performers, announcers, and airbosses about your prospective pyro/special effects contractor.
4. Check with airport authorities at previous show sites where the contractor has worked. Did the pyro/special effects team:

    a. Clean up or leave a mess for other people to deal with relative to their contractual agreements?
    b. Blow holes in the ground?
    c. Was debris (FOD) found and/or left at the site or on runways and taxiways?
    d. Conduct themselves properly regarding operations on or near runways, safety zones, taxiways, aprons, etc.?

5. What is the safety record of the contractor you are considering? Have they:

    a. Had an injury requiring hospitalization to pyro crew or spectators?
    b. Damaged an aircraft in flight or on the ground?
    c. Damaged facilities or buildings at show sight?

    Does your contractor have the necessary licenses to conduct the proposed activity at your event? In addition to federal permits, many U.S. states currently have state and local standards for “blasters” that must be met, including licensing. Your local Fire Chief or Fire Marshall can help you determine what will be required at your location and can put you in touch with the appropriate state or provincial office. Note: In some cases it may be beneficial to your contractor (or you) for him to work under someone else’s licenses.

CHAPTER 4 – THE PYRO/SPECIAL EFFECTS CONTRACTOR'S ROLE AND GUIDELINES

A. CONTRACTOR REQUIREMENTS

Many people are eligible to purchase explosives materials. While the most typical purchaser of class 1.1 and 1.4 explosive materials uses these materials in mining, quarrying, and construction operations, Federal ATF regulations allow the sale of explosives to agricultural interests. Many of these "agricultural" users have a need for stump or rock removal, at best "casual" use of such volatile products. The problem for airshow promoters stems from the belief on the part of many permitted purchasers of explosives that their use for airshow special effects purposes presents no unique problems or issues. After all, you just "cap it up and blow it up".

The first reality airshow promoters must accept is that special effects explosives work at airshows requires special training and knowledge. This training and knowledge cannot be gained simply by the commercial application of explosives in quarrying, mining, or construction, nor by the casual use of explosives in an agricultural environment, nor through military explosives training. Airshow special effects explosives use requires careful research, testing, training, and experience specifically on the use of these materials for special effects purposes in an AIRSHOW ENVIRONMENT. Consequently, the following minimum criteria are suggested by ICAS for airshow special effects explosives contractors.

1. The special effects explosives contractor should have a working knowledge of, and demonstrate compliance with, the applicable sections of the following publications. (See Section 5 – Resources, for details on how to obtain these publications)

    a. Local codes and ordinances pertaining to explosive materials
    b. Specific state/provincial codes and regulations pertaining to explosive materials
    c. ATF: Explosives Law and Regulations – ATF P 5400.7
    d. National Fire Protection Association (NFPA) Code 495, Explosive Materials Code

e. Institute of Makers of Explosives, Safety Library Publications Numbers: 1, 2, 3, 4, 12, 14, 17, 20, 22
f. Manufacturer’s Recommendations for “Prevention of Accidents in the Use of Explosive Materials”

2. The contractor should identify a "Shooter in Charge" (SIC) for each specific airshow contract. In many cases, the contractor himself/herself will serve as the SIC.

3. To be qualified as an SIC:

   a. Prior to being classified as an SIC, the individual should have a minimum of 3 years "apprentice experience" under a qualified SIC, working with special effects explosives at airshows. During this 3 year period prior to being qualified as an SIC, the individual must have actually worked with the set-up and shooting of special effects explosives at a total of at least 20 airshows.
   b. The SIC should be thoroughly trained in all FAA and other aviation related regulations regarding: proper operations on aprons, taxiways, runways, radio procedure, aircraft identification, runway safety zones, air show and performer etiquette, effects of debris (FOD) on runways/taxiways, and effects of energy shockwave on airport equipment and/or aircraft. Such knowledge can only be gained by either having private, military, or commercial pilot experience or through direct hands on experience and training under a currently qualified SIC.
   c. It is the contractor's responsibility to certify that the assigned SIC meets or exceeds all minimum qualifications

4. The assigned SIC should:

   a. Be available to communicate with all relevant airport and airshow personnel, as well as with any necessary federal, state/provincial, or local officials, prior to the first day of actual performance shooting at the airshow.
   b. Be available to receive and sign for, all shipments of explosive materials to the site.
   c. Be responsible for the storage of all explosive materials on site in accordance with appropriate federal, state/provincial, and local regulations.
   d. Have in his/her possession at all times at the airport, a fully functioning, FAA approved aircraft band transceiver, tuned to the appropriate frequency (ies).
   e. Ensure that all pyro personnel are equipped with and using appropriate safety equipment including, but not limited to safety

glasses, appropriate footwear, appropriate clothing for wear around a potential fire hazard area, and hearing protection.

f. Meet with assigned fire-fighting personnel and pre-coordinate a plan for dealing with fires. As a part of this planning, the SIC should conduct a daily assessment of environmental and weather conditions and incorporate this assessment in the plan for dealing with fire. **NOTE: See below for a more thorough discussion of fire safety.**
g. Attend every airshow briefing with other performers and coordinate daily with performers for whom special effects explosions are being provided. Additionally, in the United States, FAA Chapter 49 (change 22), Section 15, Paragraph K, and Air Combat Command Aerial Events Division, requires participation by the SIC in the daily performer briefing and notification of all performers regarding location, type, and size of all special effects charges. In Canada, Transport Canada and 1 Canadian Air Division also require the SIC's participation in presenting and reviewing specific items at the daily performer briefing.

   A Pyro Briefing checklist was developed in conjunction with the FAA, Transport Canada, and representatives of the ICAS Safety Committee and ICAS Pyro Safety Subcommittee. This briefing checklist is a required guide both in the United States and Canada for inclusion in the daily performer briefing at any airshow using pyro or explosive special effects. (see Appendix A)
h. Coordinate daily with fire fighting personnel at the performer briefing. **NOTE: This requires fire personnel attend the performer briefing each day.**
i. Oversee and regulate all communication between the pyro field and other airshow and airport personnel.
j. Develop, coordinate, and communicate an emergency plan for rendering harmless explosives and the pyro field in the event Crash/Fire/Rescue (CFR) personnel must be dispatched during the airshow. Said plan should be reviewed daily with CFR leadership.
k. Hold daily safety and information briefings with all personnel assigned to be present in the pyro field.
l. Ensure all movements of pyro personnel on aprons, taxiways, and runways comply with the standards of the airport involved, including runway safety zones, safety on air carrier operations, and that airport security regulations are not breached during any phase of pyrotechnic/special effects operations.
m. Enforce all runway and taxiway safety zones. Explosives operations should be conducted outside the runway safety zone (check with your airport manager for the zone size): and in no case should personnel be set up closer than the "hold short line" of any runway.

B. GENERAL SAFETY STANDARDS:

The following general safety standards should be followed by the pyro/special effects contractor regardless of the conditions unique to the site. These standards represent the minimum necessary safety requirements for airshow pyro.

1. The authority controlling the airport shall be advised prior to setting up the explosive operation. In addition, the Air Boss shall be informed when set up is complete.
2. Any person not authorized by the SIC shall not be allowed to enter the area.
3. Any person working with pyro/special effect operations who has a medical problem likely to be aggravated by conditions in the pyro/special effects area will so inform the SIC. These problems may include allergic reaction to bee stings or insect bites, low tolerance to sun/heat, back problems, etc.
4. The SIC shall have a first aid kit in their working area at all times during periods when personnel are present.
5. The SIC must have a daily supply of drinking fluids sufficient for all the personnel on the team. It is the responsibility of the promoter to provide these fluids to the SIC.
6. No one who shows apparent signs of intoxication, its after effects or the influence of drugs will be allowed near the pyro/special effects area.
7. The absolute minimum number of personnel necessary will be used to arm the charges. When armed, no one will be allowed in the pyro/special effects area until the SIC has determined it to be safe. **This rule applies to Crash/Fire/Rescue personnel as well as to pyro/special effects personnel.** No CFR personnel may enter the pyro/special effects area until explicitly cleared to do so by the SIC. Even in an emergency situation, fire and emergency equipment shall not enter the pyro area without direct guidance from the SIC. Unguided vehicles in the pyro/special effects area could compound the emergency.
8. Once armed, the minimum number of people necessary for safe operation will be allowed in the pyro/special effects area. The SIC is responsible for determining the minimum number of people required, but a general guideline to use is normally no more than 3 people per shoot point (1 shooter, 1 aircraft spotter, 1 trainee) plus whatever number of people manning fire-fighting equipment the SIC determines are necessary. All other individuals should leave the pyro field after setup is completed but before final arming of charges. Promoters are responsible for controlling access to the field by non-contractor related personnel.
9. The SIC will explicitly designate at least 1 other qualified individual present in the pyro/special effects area to act in their place in the event of the incapacitation of the SIC for purposes of declaring the pyro/special effects

area "safe". At the discretion of local fire and safety officials, the SIC may comply with a request to brief fire and safety personnel who will not be in the pyro area during the show, in the proper manner in which to “safe” an effect in the event of a catastrophic accident. In no event, and under no circumstances will pyro/special effects proceed without the presence of a qualified, contractor designated, SIC.

10. The SIC will be responsible for exercising control over explosive materials which have been removed from a magazine to prevent possession by unauthorized persons.
11. The SIC should never allow any source of ignition within 100 feet of a magazine or vehicle containing explosive materials or fuel.
12. The SIC is responsible to ensure that explosive materials are never exposed to flame-producing devices, impact, friction or electrical impulses.
13. No personnel will be allowed to fight fires in explosive materials. The SIC shall remove all personnel to a safe location immediately and guard the area against intruders.
14. No children or other unauthorized persons will be allowed near explosive materials.
15. “Skylarking,” horseplay or carelessness will not be permitted by the SIC on or near any pyro/special effects operation.
16. In addition to the functioning aircraft band radio specified above in the duties of an SIC, the SIC shall have at least one (1) other individual in the pyro field with a functioning aircraft band transceiver or provide another means of backup communication with the tower or "airboss" in the event of a communication failure of the primary radio.
17. The SIC shall ensure all pyro/special effects areas are clearly marked and visible to pilots and safety personnel.
18. Actual explosive effects should never be set up in active runway or taxiway safety zones or no closer than 75 feet from the edge of any runway and no closer than 50 feet off the edge of any taxiway or 50 feet outside the wingspan of any aircraft that might use the taxiway, whichever distance is greater. In no instance should any explosive effects be set up within 300 feet of any parked aircraft. In addition, the SIC should be thoroughly familiar with and comply with all provisions of FAA Chapter 49 (Change 22), Section 15, Paragraph K.
19. If at all practical, avoid placing actual explosive effects directly on the "500' Performer Line". This is the line many aircraft will fly, consequently, there is a greater likelihood of an incident/accident happening directly on the 500' line than anyplace else in the box.
20. Detonating pyro/special effects on an aircraft’s arrival or departure from the show site should be prohibited unless a detailed briefing has occurred and agreement on the use of pyro/special effects has been established. This is especially critical with military fly-passes that have not originated at the air show host airport.
21. Use of pyro/special effects for the arrival/departure of static aircraft outside the waiver period should be prohibited at all times. Use of pyro/special

effects for the arrival/departure of performing aircraft outside the waiver period should be prohibited unless specifically approved by ATC **AND** Airshow personnel. Pyro/special effect activities that occur outside of the scheduled air show time window may be in conflict with other activities that could degrade safety or that may distract other pilots (i.e., other aircraft arrivals/departures, ground traffic, ATC communications).

22. Any excess or “left over” shots can sometimes be fired on the last aircraft pyro/special effects pass. If, for some reason, material is left over at the end of the air show, it MUST be removed from the area and disposed of if applicable, or destroyed on site in a manner that is consistent with standard practices or applicable regulations.
23. The SIC should hold a daily briefing with all pyro/special effects personnel to review all safety policies and procedures.
24. The SIC should complete an "area clearing walk-around" at the conclusion of the show to ensure that all explosives materials have been expended or accounted for and that leftover materials are being removed from the site by proper transportation.

C. FIRE SAFETY CONSIDERATIONS AND PROCEDURES

One of the most potentially dangerous aspects of pyro/special effects work at airshows concerns the potential for fire. Specifically, airshow pyro/special effects are designed to produce "smoke, noise and fire", to simulate the use of various types of ordinance fired or dropped from aircraft. To accomplish this task, commercial explosives are combined with an ignitable fuel source. The "noise" is provided by the "pressure waves" generated by the detonation of an explosive product which will be discussed below. The "smoke and fire", produced by the vaporization and ignition of the fuel source results in the stunning visual and thermal effects which thrill the crowd.

One of the by-products of this later combination is residual fire. Until the initial fuel source is consumed, the fire will continue to burn. If additional fuel sources such as dry vegetation are present, the potential for fire to become uncontrolled exists. The potential for uncontrolled fire to spread is exacerbated by wind. This combination of fire, additional fuel sources and wind can quickly become hazardous.

Compounding this problem is the belief on the part of many airshow promoters that:

1. Recent wet weather will eliminate the need for concern about grass fires. This may be true on the first day, but each day’s show will further dry out the grass and the fire potential will INCREASE with each subsequent day.

2. Recently cut tall grass in the pyro area (within a week or 2) will minimize the problem of grass fires.

Certainly, both of these approaches are acceptable methods to reduce the potential for uncontrolled fire. However, both of these positions tend to overlook the fact that wet grass and piled up grass are prescriptions for the production of significant amounts of smoke. Nothing ruins an airshow for the crowd any more quickly than a smoke filled sky or chalet area that inhibits viewing.

Clearly, fire safety and control are key issues to be addressed by both the airshow promoter and the pyro/special effects contractor. The ideal pyro/special effects area should be flat, dry, and free of all vegetation. However, since most airshows are not held at the Bonneville Salt Flats, the following safety considerations should be followed with respect to the need to control fire:

1. If grass and other vegetation are present, they should be burned off 2 weeks prior to the show. This is very important and should be done to preclude uncontrolled fires that could cause uncontrolled detonations during acts using special effects support. If it is not practical to burn off the area, any vegetation should be cut as short as possible and removed from the area. This includes picking up and removal of grass clippings. Consider scraping the area clean of vegetation using a construction grader. Controlled pre-burning is the method of choice and results in less long-term harm to the property than scraping. If cutting is used, removal of cut vegetation by the promoter from the pyro/special effects area is essential.

2. Regardless of site preparation method used, the SIC MUST ensure that there is some method to fight grass fires. The fire department shall be put on “stand-by” status, readily accessible to the pyro site. Standby status requires the fire department to be on site, stationed on the "show side" of the crowd line, with a sufficient supply of water, and pre-coordinated with the SIC.
3. Always ensure that some sort of firebreak exists between the pyro/special effects area and the spectator area and aircraft parking areas. However, the existence of fire breaks such as ramps, runways, taxiways, drainage ditches, etc. does not mitigate the need for the SIC to ensure adequate fire fighting capability.
4. The SIC should always receive a daily weather briefing from the airshow weather officer. This briefing should focus on the potential for winds in the pyro/special effects area. Specific attention should be paid to maximum wind speeds and

directions. The SIC should take this information into account when planning their daily set up and shooting sequences.

It is always the responsibility of the SIC to determine whether or not environmental conditions, including wind speeds and direction, allow for the safe detonation of an explosive effect. This decision will involve many factors, including the need to dispose of explosives materials once they are set up, weather conditions such as lightning or potential thunderstorms which might result in an unsafe environment, etc. The following guidelines are suggested for consideration in making this decision but can never replace experience and sound judgment on the part of the SIC.

1. When wind speeds are less than 35 mph, it is generally acceptable to detonate explosive effects that **do not** involve the use of fuel and fire.
2. When wind speeds are in the range of 0 to 10 mph, it is generally acceptable to detonate explosive effects involving fuel and fire regardless of the direction of the wind
3. When wind speeds are in the range of 11 to 25 mph, it is generally acceptable to detonate explosive effects involving fuel and fire provided the wind direction is predominately "off crowd", meaning in a direction blowing away from the crowd or parked aircraft. It is good safety practice with winds in this range to have the fire department "spooled up" and ready to roll if needed to fight grass fires.
4. When the wind speeds are in the range of 11 to 17 mph and the wind is "on crowd", it is generally acceptable to detonate explosive effects involving fuel and fire provided the minimum distance between the explosive effects and the crowd is at least 500 feet and prior provisions have been made for fire suppression support with the fire department on site. Prior provision in this instance means the fire trucks are stationed in between the pyro field and the crowd and ready to fight fires.
5. When the wind speeds are in the range of 18 to 25 mph, and the wind is "on crowd", it is generally acceptable to detonate explosive effects involving fuel and fire provided the minimum distance between the explosive effects and the crowd is at least 800 feet and prior provision have been made for fire suppression support with the fire department on site. Prior provision in this instance means the fire trucks are stationed in between the pyro field and the crowd and ready to fight fires.
6. When wind speeds "on crowd" exceed 25 mph, the SIC should exercise extreme caution in their decision to detonate explosive effects involving fuel and fire.

D. EXPLOSIVES SAFETY CONSIDERATIONS

In addition to the wealth of information available to the pyro/special effects contractor with respect to the safe handling and use of explosives, two fundamental issues surround the use of these commercial explosive materials for airshow special effects. The first concerns the minimum safe distances for the use of these materials in a surface detonation environment and the second concerns the control of "infra sound" pressure wave damage, more commonly referred to as "Air Blast" damage.

Different explosive compositions produce differing amplitudes and frequencies. It is important to bear in mind that throughout the following discussion, all references to explosive weights is based on the equivalent weight of TNT. For example, when reference is made to one (1) pound of explosive, the reference is actually to one pound of TNT equivalent explosive. The actual weight of the composition being used may vary up or down.

1. Surface Detonation and Safe Distances

With surface detonation, one of the primary concerns is the production of "fod" and/or shrapnel. Blasting caps produce shrapnel that can travel quite some distance. In addition, explosives detonated in a surface environment can turn objects such as rocks or splinters from wooden stakes into lethal projectiles.

The production of dangerous projectiles from surface detonation of explosives can be minimized in several ways:

a. The SIC should supervise the removal of objects such as rocks, cans, bottles, broken pieces of asphalt, etc. from the immediate vicinity of any explosive effect during setup.
b. The SIC should elevate explosives off the ground in such a way that any projectiles are blown in a direction away from the crowd, parked aircraft, and pyro-technicians.
c. The SIC should ensure shoot points for pyro-technicians are located a sufficient distance from explosive effects to maximize safety to personnel in the pyro field.
d. The SIC should ensure that all personnel in the pyro field during detonation of special effects have and are using appropriate safety equipment, including eye and hearing protection.

These precautions will help minimize injuries due to the surface detonation of explosives, especially from the standpoint of the crowd. However, as an added measure of safety, minimum distances between individual explosive effects and the crowd or

parked aircraft should be observed. The recommended minimum distances are as follows:

a. Typically, an explosive effect should be set up no closer than 500 feet from the closest point of the crowd line or any parked aircraft.
b. If the geographic and physical location dictates, and if the SIC determines it is both prudent and safe to set up explosive effects closer than 500 feet (close quarter effects), the maximum possible distance should be maintained, and pyro/special effects explosives detonated only if the following conditions are met:

    1. No close quarter effect should use more than .34 (1/3) pounds of explosives (relative to TNT) total per delay, such quantity being based on the historical relationship between weight of explosives and distance from explosives with a maximum dB standard of 140 and .0246 (PSI).
    2. Rocks and other shrapnel producing material should be completely removed from the area. In the event of rocky soil, close quarter effects are discouraged.
    3. Shrapnel and/or "FOD" producing materials used in the construction of the effect should be held to a minimum.
    4. All blasting caps used in close quarter effects should be covered with soft stemming material (such as grass or dirt) sufficient to suppress the shrapnel from these objects.

2. Surface Detonation and "Air Blast".

Airblast is the term used to refer to the pressure wave produced in surrounding air by explosive gasses. In mining/quarrying operations, airblast usually results from improperly stemmed holes or a plane of weakness in the mine or quarry. With surface detonation of explosives, as in airshow pyro/special effects, airblast is especially critical due to the potential for physical damage from the pressure wave.

In research presented to the International Society of Explosive Engineers in 1997, G. Alan Foster, VP at Vibra-Tech Engineers discussed the causes and possible control of damage from "airblast". Specifically, research indicates the resulting pressure wave (airblast) moves supersonically and consists primarily of "infra sound" or frequencies in the range of 16Hz. Mr. Foster goes on to suggest that many man made structures have a natural resonant frequency in the same range resulting in the maximum transfer of energy and resulting physical damage.

One of the major problems with airblast for the pyro/special effects contractor is its relative unpredictability due to the influence of local weather conditions. For example, temperature inversions can magnify intensity of the blast wave 3 or more times. Mr. Foster concludes that "the variations in weather conditions are infinite and therefore the variations in airblast effects from similar blasts can vary widely.

Suggestions for limiting damage from airblast are found in the U.S. Bureau of Mines Technical Progress Report #78 dated May 1974. This publication suggests monitoring blast sites and limiting maximum dB levels from airblast to no more than 136 dB (0.018 psi). Long term history of application suggests a safe specification of 140 dB or .029 PSI.

The problem with applying these standards to airshow pyro/special effects explosives is that the monitoring and repeated testing at each airshow site over extended periods of time necessary to produce a profile of acceptable poundage of explosives in surface detonation under all possible weather conditions is not practical.

As an alternative, the research on airblast does suggest certain known characteristics of blast pressure waves, weather, shot design, and shot size, which, when combined with practical experience in airshow pyro/special effects, can be used to construct a set of guidelines to minimize the chances of property damage. For example, research by A. B. Andrews of E.I. Du Pont DeNemours and Company, Inc. has shown that when the rate of blast progression is less than the velocity of sound in air, individual pressure waves are not additive resulting in weaker airblast effects. Furthermore, the rate of blast progression can be reduced through the introduction of 25ms or longer delays. With respect to poundage of explosive materials in surface detonation situations, Natural Resources Canada reviewed Australian Bomb Data Centre Technical Bulletin 6-86, Blast Pressure Effects to construct the following table of distances and effects:

Natural Resources Canada Table
High Explosives and/or Black Powder

The following table summarizes the comparative, perimeter safety distances from an open-air, spherical, and unconfined explosive charge. Quantities are in pounds of explosives and distances are in feet. The table is taken from APPENDIX 5, COMPARATIVE SAFETY DISTANCE TABLE, NATURAL RESOURCES CANADA, EXPLOSIVE REGULATORY DIVISION, MARCH, 1997.

Weight in Pounds (Equiv. to TNT)	Red Zone "Closed"	Crack Windows	Crack Walls	Crack Walls	Shatter Zone "Windows"	Green Zone "Minimum Safe Distances"
1	20	27	49	82	164	312
2	23	33	66	115	213	394
4	26	43	82	148	262	492
6	33	49	82	164	295	574
10	36	56	98	197	360	673
14	43	46	115	213	394	755
20	46	66	131	246	443	853
30	52	82	148	279	509	984
50	62	98	180	328	607	1148

The data in the last column of this table represent the minimum safe distances between the crowds at airshows and various quantities of explosives. Another approach to determining acceptable quantities of explosive at given distances employs the use of various formulas based on historical perspectives from the mining, engineering, and glass disciplines. Such formulas allow you to calculate a predicted safe distance for a variety of explosives quantities. The distances produced by these formulas usually are a relationship between the location of the explosive effect and the nearest structures or buildings. While either approach is currently accepted practice in the explosives industry, since the Airshow Industry usually relates safe distances to the crowd line, we recommend using the Australian Bomb Data Centre study and Natural Resources Canada formulas as the basis for determining appropriate distances. Consequently, we recommend the following guidelines:

a. Under most circumstances, no airshow pyro/special effects explosion should contain more explosives than recommended by the following table of distance and weight:

Weight in Pounds (Equiv. to TNT)	Green Zone "Minimum Safe Distances" in feet
1	315
2	400
4	500
6	575
10	675
14	775
20	875

b. In practice as well as in most instances, the SIC should attempt to use the minimum quantity of powder necessary to produce the desired effect, rarely approaching these maximums.
c. In calculating poundage, the SIC should include both the pounds of powder used **and** the quantity of explosives contained in the prima cord. For example, 50-grain cord contains 50 grains of explosives per foot. In a 1000-foot roll of cord, you would have 50,000 grains of explosive. 7000 grains of explosive is equal to 1 pound, therefore in a 1000-foot roll of 50-grain cord you would have approximately 7-8 pounds of explosive (50,000 grains per roll divided by 7000 grains per pound).
d. Minimum delay times of not less than 25 milliseconds should be used in Pyro/special effects explosives containing more than the recommended pounds of explosives in such a way as to distribute the poundage to no more than the recommended poundage per delay.
e. Since temperature inversions are statistically more likely both one hour after sunrise and one hour before sunset, special effects explosions using more than 20 pounds of explosive (even if suppressed and/or delayed) should be avoided during these periods if possible.
f. The maximum poundage per delay may be modified either up or down by the SIC if conditions such as cloud cover, environmental factors, or location/terrain considerations warrant doing so.

E. PARTICIPATING AIRCRAFT AND PILOT SAFETY CONSIDERATIONS

Normally, aircraft will fly back and forth from crowd right or crowd left. It is recommended that aircraft do not directly overfly the pyro area, but stay behind it by 150 feet with a minimum altitude (hard deck) of 200 feet AGL. Lower altitudes may be allowed if practiced and/or defined by the performer's approved maneuvers package. If this guideline is observed, aircraft would not be directly overhead in the event of an errant detonation.

Bombs, Napalm, Wall of Fire – In addition to the above recommended offset of the flight path from the pyro area, normal timing of the simulated dropping of ordnance would dictate that the aircraft continue past the area prior to detonating explosives.

Rocket or Strafing Passes – These passes differ from bomb or napalm-type passes in that he pyrotechnic event will happen in front of the aircraft. These passes need to be specifically coordinated with all pilots involved to assure that they are expecting pyro/special effects in front of them. Otherwise, it could be a dangerous distraction.

Pilots and SIC's need to realize that "Strafing Runs" move at a fixed speed across the ground (ground speed) that is not controllable by the SIC once initiated. It is possible for an aircraft to "overrun" a strafing run. 100MPH equals @ 150 feet per second, 200 MPH equals @ 300 feet per second and so on. All the more reason for pilots to observe the established "hard deck" and "offset" outlined above.

F. FUEL SAFETY CONSIDERATIONS:

The fuel used in pyro/special effect operations is probably the most lightly regarded hazard on the location. As such, it has the potential of being the most dangerous hazard. It must be remembered that AV-gas, car gas, or jet fuel are extremely hazardous liquids. Gasoline vapor, when confined, contains the explosive potential of approximately 2 pounds of dynamite.

It should be good, clean, fuel – free from contamination and water. Contaminated fuel may not burn or may have other unexpected/undesirable effects. Also, smoke from contaminated fuel may contain toxic fumes which could drift into the crowd area. The pyro/ special effects team is NOT a waste disposal team.

Fuel should be supplied to the pyro/special effects area by a vehicle or truck equipped with a metered dispensing system similar to that used for over-wing fueling of aircraft or construction equipment. Ensure you allow ample time. Supplying fuel to the area can take from one to five hours depending on the size of the show. Make sure fuel arrives at the area at the agreed upon time so as not to delay the acts supported by your pyro/special effects contractor.

Fifty-five gallon drums are an EXTREMELY dangerous method of dispensing fuel. Use of 55-gallon drums to dispense fuel should not be allowed. UNDER NO CONDITIONS SHOULD STEEL DRUMS BE ALLOWED. Steel drums, when loaded in pickup trucks, may spark against themselves in transport or between the bed or sides of the pickup truck. Empty drums are even more hazardous than full drums**.**

Typical fuels used:

Unleaded car gas
Aviation fuel (100LL)
Jet fuel

The following procedures should be observed when handling fuel:

1. One, preferably more, 10-pound fire extinguisher approved for fuel fires should be readily available during all fueling operations. Extinguishers should be close at hand, up wind, and not stored in the rear of the pickup truck or the fuel truck during fueling operations. At least one person should be familiar with their proper operation and effective use.
2. No person should possess lighted cigarettes, matches, lighters or any type of open flame-producing device within 100 feet of a fueling operation.
3. Fuel containers for air show pyro/special effects should be of a design that minimizes or eliminates the potential for fuel spills or leaks while preventing the possibility of producing any “high energy” debris that could damage aircraft or injure persons in the area.

CHAPTER 5 – AIRCRAFT AND OTHER AIRBORNE PYROTECHNICS

To date, most pyrotechnic devices installed on aircraft or used by skydivers are categorized as fireworks and treated accordingly by federal, state, provincial and local authorities.

Generally speaking, these items may be broken down into two groups: (1) Consumer Fireworks; and (2) Display Fireworks (sometimes called Special Fireworks).

Consumer fireworks have the least amount of regulation attached to them, but still may be illegal to use or possess in certain states or localities without proper permits. These items will normally have a hazard classification of 1.4.

Note: The lower the number to the right of the decimal point, the higher the danger classification.

Display fireworks have many regulations attached to them regarding their transportation, storage and use. These items will normally have a hazard classification of 1.3 or 1.2.

The principal advisory documents for these types of items are NFPA Summary, NFPA 1124 and NFPA 1126. These documents are publications of the National Fire Protection Association. In addition, The American Fireworks News published an article in their July 1999 edition entitled “Hazard Assessment and Accident Prevention at Unusual Shooting Sites” that is highly instructive relative to aircraft/airshow pyrotechnics.

Some common sense guidelines for performers using pyro in their performances:

A. Aircraft owner, pilot, and crew must have a good safety attitude.

B. Aircraft pilot and crew should be thoroughly trained in all facets of the transportation, handling, storage, as well as the firing of all pyrotechnic items to be used. Don’t handle or use any materials you are not licensed and trained to use.

C. All airborne pyro control systems should be thoroughly tested.

D. Insist that your materials are stored at a secure, remote site at the event.

E. Owner should have access to proper storage and obtain both BATF&E/Transport Canada and any required State or Province licenses. Storage and transportation must comply with all BATF&E, Transport Canada and DOT regulations.

F. Let the event sponsor know if you are shipping material so they can watch for its arrival and store it properly.

G. Do not fly over the crowd or closer than 500' to the crowd when you have a load of pyro on board other than wing-tip smoke. When conditions warrant, increase this minimum distance to the crowd to account for wind drift of airborne pyrotechnics

H. Holders for pyro items should be aerodynamic and should completely shield the aircraft from damage in case of premature detonation.

I. The point at which the pyro material holders are installed should be kept away from areas containing fuel tanks and aircraft electrical or flight controls.

J. Airborne pyro systems should ensure no possibility of pyro causing fire on the aircraft. Pilots and crew are strongly encouraged to work with experienced airborne pyro system designers when designing and installing airborne pyro systems.

K. System design should ensure no possibility for pyro to detach inadvertently from the aircraft. All pyro systems must meet appropriate airworthyness regulations for the aircraft on which they are installed.

L. Keep the pyro firing system shunted/safed (electrically "dead") until airborne. Make sure the firing system can be shut down in flight in the event of an emergency.

M. Firing Systems should be isolated or protected from all aircraft electrical systems

N. Ground your aircraft while setting up pyro.

O. Load and set up your pyro outdoors in remote area, away from spectators, buildings and fuel storage areas.

P. Fuel your aircraft before going to the remote pyro area to load and set up. Do not fuel in the remote area.

Q. A method of positive ignition must be developed for each type of pyro used, so that it will always ignite under the conditions of flight.

R. Perform a safety check and unload any unexpended pyro in a remote area, away from spectators, immediately after your performance so as not to endanger the crowd.

S. Consider the effect of winds and altitude on the fallout and residue from burning pyro. Sparks and/or burning debris should never reach the ground or spectator areas. In addition, much of the residue of expended pyrotechnics is corrosive and should not be allowed to drift onto aircraft and automobiles on the ground.

T. Consider whether electrical storms, static electricity or radio transmissions can disturb your firing mechanisms.

U. Be aware of the potential effects of pyro on night vision and the possibility of night vertigo. Talk to other performers about their experiences and solutions. For example:

1. Have additional references available in the cockpit

2. Be aware of disorientation caused by variance in lighting conditions

3. Be prepared to fly to reference to instruments

4. Be aware of the fact that precipitation or oil on the prop will cause bright reflections from pyro

5. Make every effort to shield cockpit sight lines from pyro

6. Consider aerodynamic effect of pyro being mounted on the aircraft.

V. Brief the CFR crew on what materials are on board your aircraft. In the event of an emergency, they must be prepared to deal with the possibility of live pyro materials.

W. Have CFR crew on standby during all loading/unloading operations.

X. The pilot is responsible for knowing where his/her pyro is at all times

CHAPTER 6 – FIREWORKS

Most states, provinces and local authorities have adopted regulations that closely parallel NFPA recommendations, but be prepared for individual variances from location to location.

Principal regulatory documents: NFPA 1123, 1124 and 1126. In Canada, the principle regulatory document is Natural Resources Canada's Pyrotechnics and Special Effects manual.

CHAPTER 7 – THE ICAS/ USAF AIR COMBAT COMMAND DEMO TEAM LIST OF SHOOTERS IN CHARGE

For purposes of enhancing safety related to the use of special effects explosives demonstrations in conjunction with armed forces aerial demo teams, the United States Air Force Air Combat Command (ACC) has requested that ICAS produce an annual list of individuals meeting ICAS pyro/special effects guidelines and demonstrating both sufficient experience and a record of safety that would qualify them to work with ACC Aerial Demonstration Teams. This list, known as the ICAS Qualified Shooters in Charge List is compiled annually by an SIC Qualifications Review Group appointed annually by the Chairs of the ICAS Safety Committee. It should also be noted that 1 Canadian Air Division has adopted this same requirement and uses the same list for special effects contractors desiring to work with Canadian Air Force demo teams

This compilation is based on a review of applications submitted annual by individuals requesting inclusion on the list. The following guidelines, developed, reviewed and approved by the ICAS Safety Committee and the ICAS Board, govern this process

A. GUIDELINES FOR INCLUSION ON THE ICAS LIST OF QUALIFIED SHOOTERS IN CHARGE

1. A current Shooter In Charge [SIC] desiring annual re-certification, an Applicant desiring initial SIC certification, or any applicant desiring re-instatement as a SIC and inclusion on the ICAS list of Qualified Shooters in Charge, are required to submit a certification application after September 1, but not later than October 31 of each year, and must include all pertinent information required in the ICAS guidelines for qualified SICs. The application must contain information regarding any safety related incidents** during the previous five (5) air show seasons (calendar year to date), the disposition of any safety related incidents, and/or any claims against the SIC's relevant insurance policies.

** *An incident for the purposes of these guidelines is described as <u>any one</u> of the following:*

a. Whenever anyone is killed as a result of pyro activities.
b. Whenever any spectator claims they were injured by pyro activities.
c. Whenever any helper, worker, volunteer or pyro team member <u>obviously</u> needs medical treatment as a result of something that happened on the pyro field. (This is not meant to include minor situations where someone receives medical attention as a precaution and is treated and released, with no further treatment or appointments necessary.)

d. Whenever a claim is made against the SIC's or airshows insurance policy as a result of pyro activities.
e. Property damage exceeding, or reasonably expected to exceed $5000.00 U.S.D.
f. Any unusually "close calls" that could reasonably have led one of the above.

Failure to apply by October 31 will automatically disqualify the SIC from the list for the coming calendar year. Applications shall be sent to ICAS Headquarters, be postmarked no later than midnight, October 31, of the current year, and clearly marked "SIC application." Applications are available on the ICAS website or from the Chair of the ICAS Pyro Safety Subcommittee. A sample application in use at the time of this publication is included as Appendix B

2. Annually the chair of the ICAS Safety Committee will appoint an SIC qualifications review group consisting of the Chair of the Pyro Safety Subcommittee and two qualified SIC's with appropriate safety records. This group will review all applications and forward a recommended list of ICAS Qualified Shooters in Charge to the Safety Committee that will, in turn, forward it, with comments, to the Executive Director of ICAS for ratification by the Board.

Initial inclusion on the SIC list is dependent on compliance with all ICAS guidelines for qualification as an SIC. To be included on the ICAS list of Qualified Shooters in Charge, one must maintain a current membership in ICAS. Loss of membership in ICAS will cause one to automatically be removed from the ICAS list of Qualified Shooters in Charge.

Annual re-certification is dependent on the individual's SIC activity and safety record during the previous 60 months, demonstrated experience, judgment, the ability to safely perform with the specific special effects explosives used for approved ACC Demo Team routines, and compliance with ICAS guidelines for pyro safety at airshows.

3. Any SIC removed from the list for cause other than failure to submit an application in a timely manner may appeal the removal decision to the ICAS Safety Committee. The Chair of the Safety Committee will appoint a special appeals committee to hear individual appeals.

B. REMOVAL AND REINSTATEMENT

An SIC removed from the qualified SIC list for cause, will be required to complete the following actions before being eligible for reinstatement.

1. Take a comprehensive, written exam on the ICAS Pyro Safety Guidelines and achieve a score of 80% or more.

2. Demonstrate proficiency by retraining under a qualified SIC (s). For retraining or recertification purposes, the recommended apprenticeship is a minimum of three (3) shows, after which time, the supervising SIC {s) may certify to the Pyro Safety Subcommittee the candidates readiness for a proficiency evaluation.

3. The Chair of the ICAS Safety Committee, in consultation with the Chair of the Pyro Safety Subcommittee, will select a. proficiency evaluation SIC. The proficiency evaluation SIC will directly observe the performance and proficiency of the applicant as an SIC at an air show. The proficiency evaluation SIC will provide a written report of observations and recommendations to the Chair of the Pyro Safety Subcommittee who will convene the necessary personnel to act on the applicant's request for re-certification. At a minimum, the SIC proficiency evaluation should address Chapter 2, Section B, items 1 through 6, and Chapter 3, Subparagraphs A.4.c through m, of the ICAS Pyro Safety Manual 2nd Edition (2006). The reasonable costs for the SIC evaluation shall be paid by the applicant requesting reinstatement.

4. If, in the judgment of the Review committee reinstatement to the ICAS list of Qualified SICs is warranted, they will notify the Safety Committee expeditiously, which will, in turn, notify the Executive Director of ICAS who will, in turn, notify the applicant and ACC.

5. The applicant will be responsible for documented expenses of the proficiency evaluation SIC associated with travel, lodging and participation in the evaluation.

The ICAS Safety Committee will hear any appeals of the Pyro Safety Subcommittee's actions.

C. GUIDELINES ON USE OF PYRO WITH BOTH AIR COMBAT COMMAND AND 1 CANADIAN AIR DIVISION DEMO TEAMS

Both Air Combat Command in the United States, and 1 Canadian Air Division in Canada, publish specific regulations and requirements for the use of pyro with military demo team aircraft. These regulations include specific references to amount and type of charges, net explosive weight (NEW) allowed per effect, daily briefing procedures and requirements, communication protocols, and other safety related procedures. (See Appendix C for an example)

The regulations are specific to each demo team and reviewed and updated annually. For USAF Air Combat Command demo teams, the regulations are

available from Air Combat Command's Aerial Events Division. For Canadian demo teams, the regulations are available from 1 Canadian Air Division.

CHAPTER 8 – REFERENCES AND RESOURCES

ATF: Explosives Law and Regulations – ATF 5400.7**

Available from: Bureau of Alcohol, Tobacco and Firearms
ATF Distribution Center
7943 Agnes Court
Springfield, Virginia 22153

ETI Blaster's Handbook

Available from: Sales Development Section
Explosives Products Division
E.I. du Pont de Nemoure & Co.
Wilmington, DE 19898

Institute of Makers of Explosives, Safety Library Publications

Numbers: 1, 2, 3, 4, 12, 14, 17, 20, and 22

Available from: Institute of Makers of Explosives
1120 Nineteenth Street, NW
Suite 310
Washington, D.C. 20036
(202) 429-9280

International Society of Explosives Engineers, Various Papers and Publications, including:

Foster, G. Alan, Air Blast, - The Major Cause of Complaints from Blasting? Its Monitoring and Possible Control, 1997

Revey, G. and Painter, D., Close-In Blasting at the Tri-Met Light Rail Tunnels in Portland, Oregon, 1997

Available from: International Society of Explosives Engineers
29100 Aurora Road
Cleveland, Ohio 44139
(440) 349-4004

National Fire Protection Association

NFPA 495	Explosives Materials Codes**
NFPA 1123	Outdoor Display of Fireworks**
NFPA 1124	Code for Manufacture, Transportation, and Storage of Fireworks**
NFPA 1126	Code For The Use of Pyrotechnics in the Performing Arts**

Available from: National Fire Protection Association
1 Batterymarch Park
PO Box 9101
Quincy, MA 02269
(800) 344-3555

Manufacturer's Recommendations for "Prevention of Accidents in the Use of Explosive Materials" – Available from specific manufacturers of explosive materials (ICI, Austin Powder, etc.)

Specific state codes and regulations pertaining to explosive materials** - Available from State Fire Marshal's Office.

Local codes and ordinances pertaining to explosive materials** - Available from local city or county Fire Marshal's Office.

FAA Advisory Circular AC 150/5300-13, Airport Design** - (Runway Safety Zones, Clear Ways, etc.)

Available from: Superintendent Documents
Government Printing Office
Washington, D.C. 20402
(202) 512-1800

Title 49 of the Code of Federal Regulations (CFR), Parts 100 through 199 (Transportation, all modes) and Title 14 of the CFR, Part 139.

Available from: Superintendent Documents
Government Printing Office
Washington, D.C. 20402
(202) 512-1800

Federal Highway Administration, Federal Motor Carrier Safety Regulations, Parts 382, 383, 387, 390 through 399 (Highway Transportation)

Available from: J.J. Keller & Associates, Inc.
3003 W. Breezewood Lane
PO Box 368
Neenah, Wisconsin 54957-0368
(800) 558-5011

Federal offices in Canada with regulatory responsibility include:

Natural Resources Canada
Explosives Regulation Division
580 Booth Street
Ottawa, ONT K1A 0E4
613-995-8995

Director of Aerodrome Safety
Harvey Layden, AARM
Place de Ville, Tower C
330 Sparks Street
Ottawa, ONT K1A 0N8
613-990-1423
613-990-1423

**Principal documents that affect pyro/special effects at air shows

APPENDIX A - PYRO BRIEFING CHECKLIST

Pyro Briefing Checklist

(rev 1 05-01-04)

GENERAL PILOT SAFETY BRIEF

(The following briefing issues must be discussed and de-conflicted with all pilots during the general safety brief. Each item need only be covered by one person. Any general item covered by the briefer need not also be covered by the SIC.)

Item	Conducted by Briefer	Conducted by SIC
Exact dimensions and location of the pyrotechnics area *	☐	☐
Magnitude of explosives being used*	☐	☐
Aircraft/pyro deconfliction plan*	☐	☐
Pyro crew and crash/fire/rescue positions	☐	☐
Communications frequency and procedure*		
principal	☐	☐
secondary	☐	☐
discrete	☐	☐
Emergency procedures*		
fire	☐	☐
accident/injury	☐	☐
Pyro sequence by act*		
location	☐	☐
Strafe direction(s)	☐	☐
Bomb direction(s)	☐	☐
Altitude and flyby lines*	☐	☐
Forecast winds and effects on pyro*	☐	☐
FOD potential and effects*	☐	☐
KIO (knock it off) procedures*	☐	☐

*Note: these items comply with, and are required by ”**Addition to AFI 11-246 V1, ACC Sup 1.”** and directives from 1 Canadian Air Division

Signatures:

_____ Briefer

_____ SIC

Sample Application for Inclusion on ICAS List of Qualified Shooters in Charge for ACC Demo Teams 20____ Air Show Season

Date: _____

Application for (check one)

Continuation _____

Initial Inclusion _____

Reinstatement after a lapse of not more than two years _____

Reinstatement after removal for cause _____

Name _____ Company_____

Address _____ City_____ St_____ ZIP _____

E-mail address_____ Phone_____

Part I – ANNUAL CONTINUATION
(To be completed only by applicants on the current list applying for continuation on the list.)

1. Please list the air shows during this last calendar year for which you served as SIC using classification 1.1 high explosives specifically for air show special effects.

2. Did you have any incidents involving damage to people or property in the course of your airshow special effects work during the past five (5) calendar years? If yes please describe the incident as factually as possible, using additional sheets if necessary. (If described on a previous application, state "See previous application")

Part II – INITIAL INCLUSION
(To be completed only by applicants not on the current list applying for initial inclusion on the list.)

	Yes	No
1. I have served a minimum three year apprenticeship under a currently qualified ICAS SIC	___	___
If yes, provide the name and telephone and/or email for this SIC.		
2. During this apprenticeship, I have actually worked with the set-up and shooting of special effects explosives at a total of at least 20 airshows.	___	___
If yes, provide a notarized statement from the supervising SIC attesting to this fact.		

3. Did you have any incidents involving damage to people or property in the course of your airshow special effects work during this past calendar year? If yes please describe the incident as factually as possible, using additional sheets if necessary.

Part III – REINSTATEMENT – AFTER LAPSE OR INACTIVITY
(Applicants requesting reinstatement after a lapse of ICAS membership or inactivity of two years or less.)

	Yes	No
1. I have taken an oral or written exam on the ICAS Pyro Safety Guidelines and achieved a score of 80% or more.	___	___
If yes, attach copy of letter from Pyro Safety Subcommittee confirming score.		
2. I have served an additional apprenticeship under an ICAS qualified SIC of at least one (1) show after which the supervising SIC certified to the Pyro Safety Subcommittee my readiness for reinstatement.	___	___

3. Did you have any incidents involving damage to people or property in the course of your air show special effects work during this past calendar year? If yes, please describe the incident as factually as possible, using additional sheets if necessary.

Part IV - REINSTATEMENT – AFTER REMOVAL FOR CAUSE
(To be completed only by applicants requesting reinstatement after removal for cause.)

		Yes	No
1.	I have taken a comprehensive, written exam on the ICAS Pyro Safety Guidelines and achieved a score of 80% or more, and reviewed the situation that led the my removal for cause with a representative of the ICAS Pyro Safety Committee.	___	___
	If yes, attach copy of letter from Pyro Safety Subcommittee confirming score		
2.	I have served an additional apprenticeship under an ICAS qualified SIC at a minimum of at least 3 shows after which, the supervising SIC certified to the Pyro Safety Subcommittee my readiness for a proficiency evaluation.	___	___
3.	I have completed a proficiency evaluation conducted by a qualified SIC, selected by the Chair of the ICAS Safety Committee and the reviewer reported his or her findings to the Chair of the Pyro Safety Subcommittee.	___	___

4. Did you have any incidents involving damage to people or property in the course of your air show special effects work during this past calendar year? If yes please describe the incident as factually as possible, using additional sheets if necessary.

Part IV—To be completed by all applicants.

Attach a voided copy of your current, valid US or Canadian Federal Permit as a user or manufacturer of high explosives, and a copy of your insurance cover page showing current, valid liability insurance specifically for air show special effects liability.

By signing below, I certify that I am currently a member in good standing of the International Council of Air Shows and that the above information is true and accurate. I am aware of the definition of an incident as used in these guidelines, and I further understand that making any false representations will be grounds for having my name permanently removed from the ICAS ACC "Shooter in Charge" list.

_____ _____

Signature Date

Mail or FAX Completed Application to: ICAS, 751 Miller Drive SE, Leesburg, VA 20175 FAX 1 (703) 779-8511

APPENDIX C—SAMPLE MILITARY DEMO TEAM PYRO REQUIREMENTS

ACC A-10 Demonstration Teams Pyrotechnic Display Procedures for Addition to AFI 11-246 V1, ACC Sup 1

3.8. (Added) Pyro**.** Only qualified personnel will be permitted to utilize pyrotechnics (pyro) in association with the ACC A-10 demonstration teams. Each calendar year the International Council of Airshow (ICAS) Pyro Safety Subcommittee will identify personnel as approved ACC Shooters in Charge (SICs). Selection will be based on experience, judgment, and safety record. Only those ACC SICs selected by the ICAS Pyro Safety Subcommittee will be allowed to work with ACC A-10 demonstration teams.

3.8.1. (Added) The following maximum Net Effective Weights (NEW) will be used (all NEWs in this reg are TNT equivalent):

3.8.1.1. (Added) For strafe passes, a series of up to 40 charges will be fired, with a maximum of one pound NEW each. The “ending shot” for each strafe pass will be a maximum two-pound NEW charge.

3.8.1.2. (Added) For the bomb pass, a maximum NEW of 5 pounds will be used.

3.8.1.3. (Added) A “Wall of Fire” Pass may be substituted for the bomb pass. The maximum NEW is dependent on the length of the wall. The maximum wall length is 2000 linear feet, and the maximum NEW is 20 pounds (spread out evenly). No more than 1 pound NEW will be used for each 100 linear feet of wall.

3.8.2. (Added) The following items will be briefed by the ACC demo pilot and the SIC, in person, prior to each performance:

3.8.2.1. (Added) Exact dimensions of the pyrotechnics area and the magnitude of explosives being used.

3.8.2.2. (Added) Aircraft/pyro deconfliction plan.

3.8.2.3. (Added) Demo profile and sequence of pyro (strafe, bomb, etc).

3.8.2.4. (Added) Forecast wind and effects on pyro.

3.8.2.5. (Added) Communications plan.

3.8.2.6. (Added) Knock-it-off (KIO) procedures.

3.8.2.7. (Added) Fire hazards and fire department response plan.

3.8.2.8. (Added) FOD potential and effects.

3.13.1.1. (Added) Maneuver **Description – Pyro.** Prior to the start of the demonstration, the demo pilot or safety observer will get a radio check from the SIC. Radio contact will only be initiated by the demo pilot or safety observer, and in no instance will the SIC talk to the pilot unless safety of flight becomes an issue. Immediately prior to the first LAS pass, the demo pilot or safety observer will make a “next pass hot” call. This will alert the SIC to the first strafe run and give the SIC permission to discharge the pyrotechnics as briefed. The demo pilot will call all shots; however, he may delegate this to his safety observer. The pilot’s primary responsibility is to fly the demonstration without distraction, and radio calls between the safety observer and the SIC will be kept to the absolute minimum necessary.

3.13.1.2. (Added) Deconfliction with the aircraft will be based on altitude, timing and lateral offsets. For strafe passes, the A-10 will turn away from the target area prior to flying over the pyro (similar to real-world strafe). For the bomb or Wall of Fire pass, the SIC will not fire the pyro until the A-10 is past the pyro area and begins the pull off-target. For all passes, the A-10 will fly a ground track that is offset at least 150 feet from the A-10 pyro effect and over fly the pyro by at least 300 feet AGL. IAW AFMAN 91-201, explosives safety standards dictate a minimum of 1250 feet separation from Hazard C/D 1.1 explosive detonations to unrelated personnel. Therefore, at all Air Force Bases, pyro will be set up a minimum of 1250 feet from the crowd line. The A-10 may continue the demonstration on the 500-foot show line. For all non-Air Force Base show sites, pyro will be set up a minimum of 650 feet from the crowd line, allowing the A-10 to fly on the 500-foot show line.

3.13.2.1. (Added) Abnormal **Procedures – Pyro.** Safety is paramount. If at any time safety becomes an issue, anyone on the radio may make a KIO call. Following a KIO call, the pilot will discontinue his routine and the pilot, safety observer, and SIC will acknowledge the call. If there is ever a question of timing, safety, or sequence, the SIC will not shoot the pyro.

APPENDIX D—REMENDED CRASH FIRE RESCUE RESPONSE PLAN

Response Plan for CFR response for incidents in the Airshow Pyro Box

Introduction

The pyro box is a location at the airshow that presents unique considerations when compared to other areas at the facility due to the nature of the materials, both explosive and non-explosive, that are widely distributed throughout the pyro box and present hazards to the equipment and personnel responding to the an incident.

As a result of the complexities and risks associated with the pyro box the SIC and pyro team have an important role in supporting an effective, timely and safe CFR response to an incident that intrudes into the pyro box.

Hazards

The pyro box typically contains, and has widely distributed, gasoline, 1.1 explosives, initiators (electric and non-electric), and wire. Due to the typical flow of the aircraft during the show these materials are typically configured to be parallel to the runway or are at a 90 degree angle to the runway.

Response

Due to the somewhat random distribution of the materials throughout the pyro box it is impractical to have an unplanned approach for entry of emergency vehicles into the pyro box as the difficulty of clearing a path is complex and requires considerable time. While the age old instruction of “If it did not grow here don’t step on it.” applies it is inadequate for a defined emergency response.

Thus the most effective approach for entry into the pyro box is at a 90 degree angle to the runway. This provides a common approach that directs both the CFR response and the pyro team to a defined location enabling an unobstructed path to respond to the incident.

The response plan is as follows:

- The responding CFR units are to proceed down the runway to the location that is 90 degrees to the aircraft, vehicle, or person requiring response.

  (Note: if conditions allow a 90 degree approach from the back of the pyro box can be effective if the local conditions support a response from behind)

- The Pyro team will:
    - Send designated personnel to the location for entry of CFR into the pyro box to direct CFR into the box
    - Secure any explosives by
        - Shunting any wires,
        - Removing any batteries form shooting boxes
        - Cut cord, caps and wires as needed to clear a path (30'-50' wide) to enable a clear path to the incident.
    - Once the path is cleared the pyro team will continue to disarm the field to render it as safe as possible for the CFR responders.
    - Provide whatever assistance possible to the pilot prior to the arrival of CFR
    - Once CFR arrives and the pyro team is not needed to further assist the CFR response the pyro team will proceed to a designated point for a headcount

Once the CFR response concluded and the field is cleared the SIC will coordinate with the Air Boss for reconfiguration of the special effects for continuation of the show or disposal of the explosives and fuel.

Parachutist/Balloon landing in the Pyro Box

While the unplanned event of a parachutist or balloon landing in the pyro box does not necessarily require CFR response it does need to be addressed to provide an opportunity for safe recovery of equipment and personnel.

The actions to be taken are as follows:

- The parachutist or ballooner are to stay where they have landed until support from the pyro team arrives to guide them from the area.
- The parachutist or ballooner will control and deflate the parachute or balloon but remain stationary until escort arrives.
- If additional support from others is required the same procedures for entry into the pyro field as used by CFR will be followed.

Summary

This recommended response plan is not intended as the be all end all plan for every airshow or event. It is intended to be the foundation for a plan the fits the considerations and environment enabling the fastest response in the safest manner possible. It is important that the SIC and CFR review and finalize the plan so that plan can be briefed with the Air Boss, Event Organizers, CFR as well as the pyro team so that a common plan specific to meet the needs of the airshow is share by all and communicated as needed.