



**FLAME EFFECTS
SAFETY PLAN**

Version 1.2 Jan 2015

Contact OWFireSafety@KindleArts.ca with questions or comments. Feedback is welcome and encouraged.

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KINDLE ARTS SOCIETY

FLAME EFFECTS SAFETY PLAN

The use of fire in visual arts performances adds a dramatic and primal factor impossible to create in other ways, but also presents an unavoidable element of risk. However, it has been demonstrated that through careful observation of basic safety protocols and procedures, most if not all of this risk can be mitigated while still presenting a spectacular show.

KindleArts categorizes fire art into four broad categories:

Fire Performance using hand held tools and liquid fuel burning from a wick.

Open Fire burns of class A materials such as wood, cardboard, and cloth.

Flame Effects which are defined as all flames that are automated, switched, pressurized or having any action other than simply being lit on fire, as well as projects using propane or other liquid or gaseous fuels.

Pyrotechnics refers to the art, craft and science of fireworks, which includes any explosives, projectiles, family or display fireworks, and any other pyrotechnical articles.

All participants involved with flame effects, shall have been familiarized with these fire safety procedures and must attend the daily pre-event fire safety briefing before being permitted to operate the effect in any capacity.

All flame effects systems must be inspected by the Event Fire Safety coordinator or their delegate before they are fuelled, charged, or pressurized.

No system shall have fuel connected until all required safety measures are in place.

All flame effects operators must be clear, capable, and competent. This is a zero strikes rule. If you're not sober, you're not operating the effect.

Flame Effects must never be left unattended. Any Flame Effect found running unattended will be shut down. Egregious or repeat offenses will result in the confiscation or disabling of the effect.

As these policies have been created to keep everyone safe, any Fire Artist in violation of any of them shall be removed from the performance area immediately and their participation at the event reviewed by the organizers which could result in consequences up to and including being asked to leave the event. This may sound harsh but we take safety very seriously and will not work with those who don't.

Flame Effect Equipment Guidelines

The majority of Flame Effects we see at our events utilize Liquefied Petroleum Gas (LP), more commonly referred to as propane. Most of the guidelines below deal with propane as a fuel. Regardless of fuel type or technological basis, all Flame Effects must be constructed in such a way as to meet or exceed applicable laws, codes, and industry standards to the Event Fire Safety coordinator or their delegate's satisfaction. These standards can be found in regional and national LP Gas Codes, and the [National Fire Protection Association](#) (NFPA) documents, Sections 54, 58, and 160 which deals with flame effects before a live audience.

- **All LP-GAS CONTAINERS** shall be designed, fabricated, tested, and marked in accordance with the regulations of Transport Canada (TC), the US Department of Transportation (DOT), the ASME Boiler and Pressure Vessel Code, or other recognized regulatory authority. TC/DOT cylinders shall not be overdue for periodic requalification (typically 10 years) and shall be in good working order.

The easiest way to meet this requirement is to use commercial propane cylinders (BBQ tanks or similar) with recent date stamps for your fuel source.

- **All LP-GAS Flame Effects must have 1/4-turn shut-off valves** at each fuel supply connection as a primary emergency fuel shutoff point. These valves must be exposed and visible at all times.

This will usually be the first thing the Event Fire Safety coordinator or their delegate will ask to see during the inspection. Each fuel source needs its own shut off valve and should be as close to the fuel source as possible. If your effect uses multiple fuel containers, each container must have a ¼-turn shut off as well as any additional shutoffs you may have installed downstream such as past the manifold, etc. The main thing here is to be able to quickly and completely shut off the fuel if something goes wrong.

- **All LP-GAS CONTAINERS** shall be positioned a safe distance from the effect discharge area. This generally means at least 10 feet away from any flame, but may have to be more depending on the effect type and configuration.

Don't put your fuel tanks right underneath your discharge nozzle.

All equipment, hoses, controllers, wires, and other related items for your effect shall be sturdy, well constructed to current standards, be in good condition, and not be janky.

All equipment must always be checked for proper operation, damage or corrosion, loose parts, etc., before lighting. Nothing says oops quite like watching your pilot diffuser go flying into the sky after your first poof.

FUEL SUPPLY PIPE, TUBING, HOSES, AND FITTINGS

All fuel supply pipe, tubing, hoses and fittings shall be rated for the type of fuel being used and the maximum operating pressure of the effect.

- All LP-Gas Hoses that will be operated in excess of 5 psi shall be designed for a working pressure of at least 350 psi and shall be continuously marked by the manufacturer to indicate its maximum operating pressure and compatibility with LP-Gas.
- Air, pneumatic line, garden hose, and other rubber lines are not acceptable as fuel hose. LP gas degrades rubber hose not specifically designed for use with that fuel. This results in the hose cracking from the inside out, potentially leading to a catastrophic failure.
- **HOSE CLAMPS are prohibited on LP-Gas hoses.** All hose connections shall be factory made, or constructed with a crimped fitting specifically designed for that purpose.
- All LP-Gas metallic piping and fittings that will operate at a pressure greater than 125 psi (unregulated tank pressure) shall be a minimum of schedule 80.
- All metallic tubing joints shall be flared or threaded and taped or doped appropriately. Lead-soldered joints and compression fittings are prohibited, but silver-soldered or other high-temp brazed connections are allowed.
- Standing or static flame art pieces shall have at least 5 feet of copper line or metal pipe as a heat sink to prevent fuel hoses from overheating and failing.
- All fuel hoses must be protected from heat, flame, abrasion, and other damage.

Use proper propane hoses, flared copper lines, and sched 80 pipe and you won't have a problem.



FUEL ACCUMULATORS

Accumulator tanks for use with flammable or liquefied gas shall be designed, manufactured, and tested in accordance with CSA B51 or ASME Boiler and Pressure Vessel Code or Transport Canada or US Department of Transportation (DOT) or other recognized regulatory authority for the pressure of the gas in use.

- If the gas supply pressure exceeds the maximum allowable operating pressure (MAOP) of the accumulator, a regulator shall be installed between the fuel supply and the accumulator to reduce the pressure below the accumulator's MAOP. A pressure relief valve shall also be installed in the accumulator with a start-to-leak setting at or below the MAOP and a rate of discharge that exceeds the flow rate of the supply container.

Use proper pressure vessels for your accumulators. Home made accumulators (stick welded out of tube steel, etc.,) rarely pass inspection. Commercial propane cylinders work well here, too.

SAFE CLEARANCES, PERIMETERS, AND AREA OF EFFECT

Flame effects must always be operated in a safe and reasonable manner. Never in a way that will put people, the venue, or other property at risk.

For larger flame effects a safety perimeter and clearance from other art or flammables may be needed. Please discuss your perimeter plans with the event fire safety coordinator or their delegate during your inspection or at an event safety meeting.

Your effect should be designed to keep any open flame well above participants' heads, generally at least 10 feet above the ground, and should always be pointed up unless your effect or art specifically requires another orientation. Please discuss any non-upwards discharge orientation or lower flame heights with the Event Fire Safety coordinator or their delegate during the inspection or safety meeting.

Have fun, but don't hurt anyone or burn the venue down.

DAILY SAFETY CHECK

A detailed inspection of all flame effects, fuel systems, materials, hoses, pumps, wicking, pressure tanks, etc. shall be performed by the effect operator before the performance or installation begins each day or night of the event. If any safety concerns have been identified, they will be resolved to the satisfaction of the event fire safety coordinator or their delegate before the effect or installation is permitted to be operated.

Check your stuff out every day before you light it. Things can move when they heat up and cool down, and there are gremlins everywhere.

GENERAL FIRE ART SAFETY GUIDELINES

CLOTHING

Clothing worn by all persons operating flame effects should be made of natural materials such as cotton, hemp, leather or other non-flammable fabrics such as Nomex.

NO FLAMMABLE SYNTHETICS! Polar fleece, nylon, poly-blend onesies, etc.

Debridement of melted plastics from your skin in the ER while everyone else is enjoying the party is not something anyone wants to experience.

FIRE EXTINGUISHERS

All fire art or flame effect installations must have a fire extinguisher appropriate for the fuels in use close to hand at all times.

The effect operator(s) should have fire extinguisher training.

Fire extinguishers should be up to date and tagged.

FUEL STORAGE

No smoking or open flame is allowed near fuel or flammable storage areas.

All fuel and flammables should be secured in approved containers, stored in a safe and secure area located a minimum of 50 feet away from any open flame.

Don't fill your camp with spare fuel bottles. Have a plan for all of the fuel you're going to use throughout the event and educate yourself about local transport and storage regulations.

EXOTIC FUELS AND ADDITIVES OR COLOURANTS

All exotic (non-LP gas) fuels, additives, colourants, or other pyrochemicals and their SDS/MSDS must be inspected and approved by the Event Fire Safety Coordinator or their delegate before being used. An SDS/MSDS will be provided for review and kept onsite for all chemicals used.

EMERGENCY PROCEDURES

Any of the following are considered emergencies and shall be addressed immediately with the following or other appropriate procedures:

FIRE IN OR NEAR FUEL SYSTEM

Call 911 if required and move everyone away from the fire scene.
All non-safety personnel leave the area calmly but quickly.
Shut off main valve if possible.
Remove other fuel containers if possible.
Extinguish fire if possible.

**DON'T BE THE HERO. IF THE FIRE IS TOO BIG,
GET AWAY AND USE AN EXTINGUISHER OR CALL 911**

PARTICIPANT GETS TOO CLOSE TO FLAME EFFECT

Effect will be shut down and safety crew will intercept and remove the participant.
If you are operating solo, shut it down and get them out of there.
If there is any problem with immediate removal – they're drunk, combative, etc., shut the effect down and ask a ranger for help.

FUEL LINE BREAK OR STRUCTURAL FAILURE

Close primary fuel supply valve.
Shut down effect and de-power system.

CLEAN-UP AND LEAVE NO TRACE

All fuels and chemicals will be kept in appropriate tightly closed containers and only opened when required.

Fuel spills must be immediately and completely cleaned up. Remove all contaminated soil from the site and dispose of it appropriately.

Leave no trace. Remove all garbage, ash, and debris following your performance or installation. Carefully walk around your area, particularly if you had to do any repairs or construction. Restore the ground if you buried or trenched any lines or anchors.

Leave the site better than you found it.

FLAME EFFECT INSPECTION CHECKLIST

ART PIECE / EFFECT		APPROVED Y/N
ARTIST		
DATE		
INSPECTOR		

All 'must' requirements have to be met to pass inspection. Approval will not be granted to systems failing inspection and may not have fuel connected or be operated at the event.

See guidelines and inspection notes beginning on page 5 of this checklist before starting.

1. Fuel tank assembly	OK / NO
A. Tank expiration date/re-certification sticker must be within 12 years of tank stamp/5 years from re-certification sticker. Tank must have stamp on it regardless.	
B. Tank body must be free of deep rust and major dings and dents. Check the bottom carefully, as this is usually the first place to rust.	
C. Foot ring must be in good shape, able to support the tank and attachments.	
D. Tank fittings must be brass or Schedule 80 pipe to the regulator, dump valve, or next stage of the system.	
E. OPD valve must not be covered in extensive corrosion or greening which indicates that the valve is likely compromised.	
F. Protective collar must be present and in good shape, able to protect valves and fittings.	
G. Must have a 90 degree ball valve after the connection to the fuel tank/s. This must be marked as rated for LP Gas, and have a WOG/CWP rating of at least 350 PSI, and be free of corrosion or greening. This valve can be on the outflow side of the regulator.	
H. Fuel tank should be anchored to prevent accidental tipping over.	

2. Regulators	OK / NO
A. Regulator must be designed for LP Gas.	
B. Appropriate pressure ratings must be stamped on the regulator.	
C. Pressure gauges are not necessary, however they are desirable.	

3. Piping	OK / NO
A. Piping running above 125 PSI (unregulated tank pressure) must be Schedule 80 metal pipe. No PVC is allowed.	
B. Piping running below 125 PSI should be a minimum of Schedule 40 metal pipe.	
C. Any piping that will be under pressure must be free of major kinks, holes, welds, or modifications with the exception of the discharge or egress pipe which may have modifications as it will not be under pressure.	
D. Brass piping, fittings, and valves must be free of corrosion or greening.	
E. Iron piping must be free of deep rusting or pitting which could compromise its integrity.	
F. Threaded joints must be taped or doped with LP gas compatible sealants.	
G. Flared joints must not be taped or doped.	

4. Hoses	OK / NO
A. Any hose used for LP gas that is running above 5 PSI must be rated for LP Gas and have a pressure rating of 350 PSI. These markings must be on the hose and marked continuously along its full length.	
B. Visually inspect for cracks and holes in hoses. Any hoses with cracks/holes must be replaced. Patches to hoses are not allowed as the patch may not be able to withstand the pressure placed on the hose.	
C. Hoses must be kept out of the direct or indirect path of open flame in the effect. All hoses should be reasonably out of the way of any heat sources and protected from mechanical damage where appropriate. Too much heat will cause the hose integrity to become compromised.	
D. Hoses that lead to the egress point of the effect must have a minimum of a 2 ft of piping from the egress point, to the connection of the hose. DISTANCE UNDER REVIEW AND MAY CHANGE	
E. Hoses that lead to static flame effects should have at least 5 ft of metal tubing from the closest static flame to the hose connection. For iron piping, this should be 1ft minimum, with an extra foot for every extra ¼ in over a ½ in of inner diameter. This is to allow a section that will help with the cooling of the pipe to prevent damage to the hose.	
F. Hose clamps and field-installable compression fittings are not permitted. Hose terminations must be crimped or factory installed with a fitting specifically designed for that purpose.	
G. Quick-connects must be rated for LP gas and should be double end shutoff types. Air line connectors are not permitted.	
H. Under no circumstances shall clear tubing, garden hose, air line hose, or other hose not rated for LP gas be used in any manner to carry LP gas of any pressure.	

5. Copper tubing	OK / NO
A. All fittings should be flared. Lead-soldered connections are prohibited. Silver-soldered and brazed connections are permitted.	
B. Copper tubing may only be under pressure only if it's of type K (Green print), L (Blue print), or ACR (Blue print) as these are designed for LP gas.	
C. Copper tubing that is not holding pressure may be of other types.	
D. Tubing shall be free of kinks, holes, and cracks in places where it is not designed by the builder/operator to release LP Gas.	

6. Accumulator tanks (Much the same as Fuel tanks)	OK / NO
A. Tank expiration date/re-certification sticker must be within 12 years of tank stamp/5 years from re-certification sticker. Tank must have stamp on it regardless.	
B. Tank body must be free of deep rust and major dings and dents. Check the bottom carefully, as this is usually the first place to rust.	
C. Verify that piping to/from the accumulator meets pressure standards (see piping)	
D. Accumulator should be securely anchored to prevent accidental tipping.	

7. Valves/Solenoids	OK / NO
A. Ball valves must be marked as rated for LP Gas, and have a WOG/CWP rating of at least 350 PSI. Follow the above guidelines for visual inspection for piping.	
B. Solenoids should be of the "Normally Closed" type. "Normally Open" type solenoids must have another form of closing of the system afterwards and per design.	
C. Solenoids must be marked as being compatible with LP Gas or have other evidence of being constructed from LP gas-compatible sealing materials such as Viton, Buna-N, or Nitrile.	
D. Any other valves must be marked as rated for LP Gas, and have a WOG/CWP rating of at least 350 PSI.	
E. Operator must activate the solenoid while no gas is in the system to verify that it works.	
F. Solenoid must not leak propane when closed. Once system is charged with propane, allow it to sit for a while to check to see if you begin to smell propane. This is to test if the solenoid is functioning properly, and not allowing any LP gas to leak through.	

8. Discharge / Egress point	OK / NO
<i>Dynamic Effects (A flame that rapidly changes size. Poofers, etc.)</i>	
A. The egress point should be at least 10 ft the ground, or at least 4 ft above the audiences heads (assuming someone 6ft tall) for effects that are not level with the crowd. For instance, a poofer on the ground needs to have the egress point 10 ft above the ground. If a raised platform is near a poofer, the egress point would need to be at least 4ft above their heads.	
B. Ground based effects will be allowed as long as the operator has a safety plan and a perimeter to control access in the area with the fire, and has enough people to enforce the safety plan.	
C. There should no flammable or meltable objects attached close to the egress point.	
D. Area above and directly to the sides of the egress point should be clear of flammable/meltable objects, with the exception of ignition sources. Ignition sources that have electrical components should have some form of shield to protect the wires from the heat.	
<i>Static Effects (A flame that will stay at relatively the same size the entire time while in operation. Burners, Reubens tubes, etc.)</i>	
AA. The egress point for propane in a static build should be free of flammable substances within reach of the fire, and at a safe distance from ambient heat from the piece.	
BB. These may be at any height, although if the flame effect presents a burning danger from coming in contact with the piece (hot metal, direct flame contact possible, etc.) then extra precautions may need to be taken to prevent accidental injury.	

9. Shutoff and Deadman Switches	OK / NO
A. Should be able to be deactivated by a single action (flip key switch, hit button, turn quarter-turn valve, etc.)	
B. The deactivating method should cover pressurized systems AND pilots in one action.	
C. Should be able to be deactivated in a way that can't be reactivated by a passerby (remove battery, remove connector, remove key, remove valve handles)	
D. Electronics should be "fail-safe" so that disconnected power or broken wires causes solenoids to close. Systems that can lower discharge ports below horizontal should have position sensors to determine when it is safe to fire. Control systems for pieces like this should all being done such that a broken or failed switch will never result in a false "safe" indication.	

FLAME EFFECT INSPECTION GUIDELINES

Flame effects have many working parts and considerations that must be looked at before giving approval. This includes everything from testing for leaks and inspecting wiring, to checking to make sure that the surrounding environment can handle the FE firing.

You will need to include verbal, visual, and tactile checks to make sure that the piece will work safely. The articles below are guidelines that you can use to inspect a piece to ensure safety.

Operational Safety

Verify that the operator has at least one fire extinguisher (5lb or more) that is rated to be used with LP Gas fires. These can be B:C or A:B:C. Water extinguishers will not work for gas fires, however they are encouraged in case of a secondary fire to flammable environment (grass, tent, wood) that is burning without the assistance of LP gas. These extinguishers must be near, but not next to, the rig in case it cannot be approached due to a fire. They also must be readily accessible at the time of the inspection. Extinguishers should also be verified to be charged to the appropriate levels by the built in gauge, and must be within the expiration date.

Discuss with operators what they would do in an emergency situation. Ask questions about what their plans are in case of small/large unplanned fires and propane leaks. Get them to think about these situations so that they aren't surprised by them if they occur.

Stress the importance of the 90 degree ball valves to shut off fuel sources.

All flame effects that do not have a flame verification system must be attended to at all times.

Environment

Make sure there are no overhanging trees or structures that are in the direct path, or in the immediate area of the estimated flame. Regulator pressure will directly relate to the area that should be clear above and around. This can allow for the effect to be adjusted when wind changes during operation.

Operation is prohibited in high wind (15 mph and above). This should be expressed to the operator. Anything above a gentle breeze should see a shutdown of dynamic (poofing) effects. Operators will also need to keep an eye on their static effects to make sure they do not blow out.

Also pay attention for tripping hazards that the flame effect equipment may present. If something strikes you as a readily apparent tripping hazard, point it out to the operator. If they cannot readily fix the tripping hazard, have them set up a perimeter/barrier that does not allow anyone in. Any obstacles should be well marked and visible for day or night time. No one should ever have to walk over anything near a rig.

Perimeters should be set up to be larger in circumference than the flame that the rig produces, measured from the point of egress. Any dynamic flame effect should be tested, and if necessary, the perimeter should be adjusted based on the testing at the time of the inspection.

Anchoring

All effects must be properly anchored to the ground by use of ground anchors and appropriate tie downs (cables, ratchet straps, etc.) or secured directly to a stable structure or mutated vehicle. The effect head or any flame source should not move in the event that someone falls into the device. Supply tanks do not require anchoring, but it is recommended that they be secured against accidental tip over. Bungee cords should not be used as they will stretch and allow the tank to move. Supply tanks that are set in water baths should have some form of system to prevent them from floating and tipping over. Suggestion- 55 gallon barrels with eye hooks on the side and metal bars that fit around the neck of the tank and attach to the water basin have been shown to work well.

Leak testing

Using a leak detection fluid, or soapy water (recommended a dish soap that does not have ammonia), spray all joints in the system that maintain pressure. If there is a leak, this will start to bubble up. The quicker the bubbles grow, the bigger the leak. Take your time looking at each connection to make sure that very small bubbles are not forming as well. Generally wait 5 to 10 seconds minimum for each close group of connectors. If there is any question if it's bubbling, spray it again and watch for longer. Keep in mind that your spray bottle might create tiny bubbles when it's sprayed on. Work your way from the start of the fuels path in the system to the end.

A good method is as follows:

1. Turn on the gas on the fuel tank. Spray connections between the fuel tank and the 90 ball valve. Make sure to spray the fuel tanks connection to the OPD valve as well.
2. Open the 90 degree ball valve and let gas flow into the accumulator. Spray all connections that has pressure in the system. (if the system has more 90 degree valves, inspect up to the stopping point of pressure, then open the valves and inspect to the next step.)
3. When checking hoses, spray the connector, as well as the ferrule where it meets the hose to ensure that it is properly sealed.

If any piece shows a leak in the system, the operator (not you) can attempt to tighten the connection. After this, spray for leaks and check again. If the leak still exists, turn off the gas and set all 90 degree ball valves to off. Verify that no one within the immediate area has an open flame or is smoking. Expel the gas pressure from the system before the operator attempts to disassemble it. After the operator has fixed the compromised connection, run through a leak check from start to finish again. This is important because other pieces may have become loose when disconnecting other pieces.

Initial firing

After all visual and leak checks have passed. Have the operator demonstrate a full live fire test of the system. Watch the flame to ensure that it will not endanger anyone or anything surrounding. Watch the system to verify that it is structurally stable and minimal shaking during operation.

Repairs

Absolutely, positively, under **NO CIRCUMSTANCES**, should you repair any aspect of anyone's flame effect. If something is leaking, or needs to be replaced, only the person signing off responsibility should do the repair work. This is so that you do not end up with any liability should something go wrong.

Extra Notes

Hand held FE: A lot of people are building their own, or bringing commercially bought (weed burner, brush torch) hand held flame effects these days. If your event allows them, please do the normal leak checks on these. You will also need to have a more in depth discussion with the participant who has it about using it safely. These will include not pointing it at another person, looking around before using it to make sure the area is clear. Operator must be sober when using it.

