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National Wildfire Coordinating Group

NWCG Standards for Aerial Ignition

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The *NWCG Standards for Aerial Ignition* (NSAI) establishes the standards for approved aerial ignition operations for use by all cooperating natural resource agencies. Participating agency aviation manuals contain the authority for implementing this guide. This publication:

- Defines procedures and equipment to ensure that all aerial ignition operations are performed in a safe and efficient manner.
- Provides a framework within which areas, regions, states, and local units can provide supplemental, site-specific guidance.
- Establishes a method to evaluate and approve aerial ignition devices not currently approved and outlined in this publication.
- Supplemental documents for the *NWCG Standards for Aerial Ignition* (NSAI), PMS 501, are separate to enable the use and editing as appropriate: https://www.nwcg.gov/publications/501.

The National Wildfire Coordinating Group (NWCG) provides national leadership to enable interoperable wildland fire operations among federal, state, Tribal, territorial, and local partners. NWCG operations standards are interagency by design; they are developed with the intent of universal adoption by the member agencies. However, the decision to adopt and utilize them is made independently by the individual member agencies and communicated through their respective directives systems.

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Chapter 1 – Introduction

Scope

If an agency chooses to incorporate the *NWCG Standards for Aerial Ignition* (NSAI), PMS 501 as policy within the agency's directives system, it is essential that the user understands the use of language in the NSAI regarding mandatory or optional compliance. The use of the verb "must" conveys mandatory compliance; use of "should" conveys required compliance except for documented justifiable reasons; and use of "may" and "can" conveys optional compliance.

While it is recognized that field offices from most participating agencies have the authority to issue more restrictive guidance and directives than that contained in the NSAI, they are encouraged not to do so in the interests of the guide's objective to promote interagency standardization of aerial ignition operations. Exceptions to the NSAI may only be authorized through agency specific procedures.

Many of the qualifications in the NSAI are agency specific positions and can be found in the *Federal Wildland Fire Qualifications Supplement* (https://iqcsweb.nwcg.gov/.) rather than the *NWCG Standard for Wildland Fire Position Qualifications*, PMS 310-1. Agencies choosing to adopt NSAI as policy may need to develop or add their own supplemental training and qualifications program.

Authority

The aviation directives of the participating agencies contain the authority to require implementation of this guide as policy.

Resource Operations

The United States Department of Agriculture, Forest Service (USFS), and the United States Department of Interior (DOI) Bureau of Land Management (BLM), Bureau of Indian Affairs (BIA), National Park Service (NPS), and United States Fish and Wildlife Service (USFWS) have adopted the NSAI as policy for all helicopter aerial ignition operations. Each state agency possesses the authority to require implementation of this guide as policy.

Overview of Aerial Ignition

Since its inception in western Australia and its subsequent adoption by other land management agencies, aerial ignition devices, as a means of fuel reduction, have been effectively employed to reverse fire exclusivity on a landscape level and have allowed for the increased controllability of wildfires without the requisite manpower that was historically needed.

Aerial ignition devices, which were first used on fixed-wing aircraft, have been modified to work on rotor wing and unmanned aerial systems (UAS). While the delivery method has changed in terms of both aviation platforms and the aerial ignition devices themselves, the criteria for the development of these devices and their continued usage remain the same — they provide a readily available, cost effective, environmentally acceptable way of igniting a large area of ground fuel in a short amount of time without causing undue damage to the overstory.

Aerial ignition is a beneficial tool for land managers to use in applying fire to landscapes to meet management objectives. Aerial ignition must be applied using risk management tools that can reduce risks to ground personnel and aviation crews. It is paramount users of this tool understand the potential consequences of the aviation hazards and application of fire over large areas.

Aerial ignition is a dynamic and tightly coupled system — it requires a thorough knowledge of wildfire environmental factors, aircraft performance and limitations, devices and associated procedures, and agency policy surrounding its usage.

Objectives

NSAI is intended for agencies that perform aerial ignitions. It describes the personnel, equipment, and procedures used in aerial ignition operations. It provides a framework from which areas, regions, states, and local units can provide supplemental, site-specific guidance. It establishes a method to evaluate and approve new or modified aerial ignition devices. Most importantly, it provides risk management guidance to ensure that aerial ignition operations are performed as safely as possible.

Organization

The chapters of the NSAI list the requirements, equipment, and procedures for agencies that utilize aerial ignition and serve as a guide for personnel conducting those operations. The appendices provide the user with operational and administrative forms, including but not limited to checklists, equipment modifications, and job aids.

Chapter 2 – Aerial Ignition Position Qualifications

This chapter identifies the position prerequisites and qualifications for individuals involved in aerial ignition operations. To meet the minimum qualifications, individuals must be trained, experienced, certified for each specific aerial ignition device, and possess updated aerial ignition system qualifications. Position requirements apply to both incident and prescribed fire operations.

Qualifications

To be qualified in an aerial ignition position, individuals must be current with all applicable *Federal Wildland Fire Qualifications Supplement* requirements and meet all the prerequisite training and experience standards, https://iqcsweb.nwcg.gov/.

Instructor Qualifications

1. Helitorch lead instructors must be currently qualified as both a Helitorch Manager (HTMG) on specific helitorch devices, and a Helicopter Manager (HMGB).
2. Plastic Sphere Dispenser Operator (PLDO) lead instructors must be currently qualified as a PLDO on specific aerial ignition devices, and as a Helicopter Manager (HMGB), or previously qualified as or less currency as HMGB.
3. Instructors must be approved by a regional Helicopter Operations Specialist or a state or regional Aviation Manager.

Position Certification

In the USFS, certification is the responsibility of the forest Incident Qualification Certification System (IQCS) committee. For DOI bureaus, certification is accomplished through bureau or agency authority in accordance with individual agency policy.

The course leader should document the training according to the agency requirements. Contact a USFS or Office of Aviation Services (OAS) training specialist for specific information.

Initial Training

Initial training for helitorch and plastic sphere dispenser (PSD) operations will be done in-person. Training for helitorch and PSD operations will use Interagency Aerial Ignition Unit (IAIU) approved training materials. The approved PSD and helitorch lesson plans are available on the NWCG website at: https://www.nwcg.gov/committee/interagency-aerial-ignition-unit.

Additional Training

1. Additional model-specific training is required on devices not covered in initial training.
2. This training will be documented on Aerial Ignition Device Additional Training form, found in Appendix A and B (https://www.nwcg.gov/publications/501).
3. This can be done in the classroom or the field on a wildland or prescribed fire.

Certification

1. A Position Task Book (PTB) must be completed and documented in IQCS or Incident Qualifications System (IQS).
2. The Firing Boss (FIRB) or assigned aerial ignition supervisor may also serve as the PLDO trainer, if qualified as a PLDO.

Annual Refresher

An annual refresher shall be attended to update personnel with any policy, equipment, or aviation changes. The format and the length of time of the refresher shall be determined by aviation management staff. Instructors must meet qualifications identified in this document.

1. The annual refresher shall, at a minimum, consist of a review of previous aerial ignition devices and life support equipment issues through SAFENETs/SAFECOMS, equipment changes, policy changes, and updates to the NSAI.
2. RT-9012, Helitorch Manager Refresher, and RT-9016, PSD Operator Refresher will be used to document refresher training in IQCS and IQS.

Currency Requirements

Each member of a helitorch module or PLDO must perform in the position at least once every three years in accordance with *Federal Wildland Fire Qualifications Supplement*, https://iqcsweb.nwcg.gov/.

Recertification:

If qualification currency is not maintained, a recertification and trainee assignment must be completed in order to recertify in IQCS and IQS. A refresher may be used in the recertification process along with a trainee assignment.

Aerial Ignition Organization Chart Requirements

See the organization charts in Appendix A and Appendix B (https://www.nwcg.gov/publications/501) for required positions to be filled for both prescribed and wildland fire aerial ignition.

Aerial ignition operations must be overseen by an appropriately qualified supervisor. For prescribed fire operations, only a FIRB, a Type 1 Burn Boss (RXB1), or Type 2 Burn Boss (RXB2) may direct aerial ignition operations. For a wildfire, a FIRB, RXB1, RXB2, Division Supervisor (DIVS), or Operations Section Chief (OSC) may direct aerial ignition operations.

Note: "Aerial ignition supervisor," as used in this guide, does not refer to a particular NWCG position, rather it is a generic term used to describe any of a number of NWCG positions that directs aerial ignition operations. Throughout the rest of this publication, the supervisor of the aerial ignition operations will be referred to simply as the "aerial ignition supervisor."

Requirements for personnel working under NWCG positions shall follow the *NWCG Standards for Helicopter Operations* (NSHO), PMS 510, The *Interagency Helicopter Pilot Practical Test Standards*, or the *NWCG Standards for Wildland Fire Position Qualifications*, PMS 310-1.

Aerial Ignition Supervisor:

Organizational Structure

- The PLDO, HTMG, or Unmanned Aircraft Systems Pilot (UASP) (Carded Aerial Ignition (Ai) Remote Pilot) works directly for the aerial ignition supervisor.

Aerial Ignition Specific Responsibilities

- Has authority for and directs the aerial firing operation;
- Briefs the pilot and other relevant personnel on the firing plan;
- Instructs the pilot on the firing sequences, and for PLDO, instructs the PLDO on firing sequence;
- Keeps the pilot, PLDO, ground resources, and other relevant resources informed throughout the operation.
- For PSD operations, may be present in a helicopter with the PLDO in another aircraft (or at some other vantage point). For UAS Ai, the assigned Firing Boss or aerial ignition supervisor stands close to the UASP Ai who controls the aircraft through use of a ground control station that shows the location and activity (for example, ignition points) of the aircraft.
- For helitorch operations, may be present in another aircraft (or at some other vantage point).
- Participates in fire and aircraft briefings, mission aviation safety plan (MASP) review, and the Go/No-Go Briefing Checklist.

Additional Recommended Training for FIRB Includes:

- Attendance at aerial ignition initial Helitorch, PLDO training, or both.
- DOI agency specific recommended training:
  - A-310, Crew Resource Management (CRM).
- USFS agency specific recommended training:
  - S-270, Basic Air Operations
  - CRM 7, Skill Training
  - Qualified or previously qualified as Helicopter Crewmember (HECM).
  - The ability to operate aircraft radios.

Helicopter Manager

Common duties and responsibilities are outlined in the NSHO.

Aerial ignition specific responsibilities:

- Participates in the MASP, Go/No-Go Briefing Checklist
- HMGB may have collateral duties as the PLDO or FIRB.
- On operations using only one helitorch helicopter, the HMGB may have collateral duties as the HTMG or Helitorch Parking Tender (HTPT).

Pilot:

The pilot will follow the ignition plan under the direction of the aerial ignition supervisor. The pilot-in-command is responsible for all matters related to aircraft operations and safety, weight and balance and performance planning, aerial ignition device installation oversight, and helicopter load calculation.

Aerial ignition specific responsibilities:

- Pilot is responsible for all helicopter operations and flight safety.
- Both the pilot and aircraft must be carded for the intended mission and the pilot for aerial ignition procedure being used.
- Has been briefed on aerial ignition device and installation procedures.
- Attends helibase and operational briefing.
- Before operations commence, the pilot will participate in the MASP and the Go/No-Go Briefing Checklist.
- Discusses how winds and topography may affect flight patterns with aerial ignition supervisor.
- Understands aerial ignition commands. Communicates and coordinates with the aerial ignition supervisor, manager, and associated aerial ignition positions when applicable.
- Maintains appropriate airspeed and altitude above the ground while staying within the burn area.
- Maintains reserve power and airspeed in the event of an emergency.
- Adheres to helicopter contract and applicable flight rules and regulations.
- For PSD-specific tasks, see chapter 4, Plastic Dispenser Operations.
- For helitorch-specific tasks, see chapter 5, Helitorch Operations.

Plastic Sphere Dispenser Operator (PLDO)

Position Responsibilities:

- Serves as PLDO for the aerial ignition supervisor.
- Briefs pilot and identifies safety requirements at the operations briefing,
- Monitors overall operation and provides information on aerial safety procedures to be used by the aerial ignition supervisor.
- Prepares, installs, operates, maintains, and cares for the PSD.
- Verifies for the aerial ignition supervisor that prescribed spacing of ignition is occurring and makes the necessary adjustments as directed.
- Determines if malfunction occurs and acts accordingly.
- Communicates with the pilot and aerial ignition supervisor on all procedures associated with operation and emergencies that occur during the operation.

Helitorch Manager (HTMG)

- Supervises and monitors the overall helitorch operations on the helibase.
- Supervises all helitorch and helibase operations, assigns qualified personnel to positions, and identifies trainees.
- Ensures aerial ignition Project Aviation Safety Plan (PASP) or MASP and checklists are completed, approved, posted, and followed.
- Maintains a helitorch maintenance log and ensures proper cleanup of equipment prior to storage (reference maintenance in Appendix B, https://www.nwcg.gov/publications/501).
- Provides technical assistance to aerial ignition supervisor on helibase location and operation.
- Ensures all required equipment is on-site and operational.
- Ensures communications link between helitorch base/helibase, dispatch, aerial ignition supervisor, and designated personnel is operational.
- Conducts briefing and provides technical advice and information to involved parties.
- Conducts and documents a risk assessment. Identifies hazards and safety requirements at operations briefing.
- Ensures that safety precautions have been completed prior to mixing.

Helitorch Mixmaster (HTMM)

- Supervises mixing and filling operation.
- Assures bonding procedures are followed.
    - Determines quantities of fuel and gelling agent needed and manages time frames between mixing systems.
- Oversees hookup of helitorch to helicopter.
    - Preflight tests of helitorch with pilot.
- Supervises the helitorch fire protection organization.
- Places equipment and ensures it is operational.
- Conducts drills prior to operations to ensure mixing and filling operations are coordinated between all personnel.
- Performs maintenance and cleaning of all helitorch equipment.

Helitorch Parking Tender (HTPT)

- Checks hookup of the helitorch to helicopter.
- Must have a radio equipped with headset and hardhat or an Aviation Life Support Equipment (ALSE)-approved flight helmet with a remote transmit switch during takeoffs, landings, and during helitorch operations at the landing pad.
- Has fire protection and crash rescue responsibility for the primary helitorch helipad (ensures fire extinguisher is staffed during all fueling, reloading and filling operations, as well as during takeoffs and landings).

- Ensures electrical switches are on prior to takeoff, off after landing, and inspects discharge valve, propane pressure, camlock, drum hardware, and suspension cables prior to takeoff.
- Maintains communications with helicopter while within the area of helitorch base; turns communication over to aerial ignition supervisor when helicopter departs helitorch base area.
- If the cables become tangled over the helicopter's skids, under no circumstances will any individual walk underneath the hovering helicopter to untangle the lines. The parking tender must direct the pilot to place the helitorch on the ground and release it before re-hooking.

Helitorch Mixing Personnel (Optional)

- Assists HTMM with mixing gelling agent and filling the helitorch.
- Performs any other miscellaneous tasks during helitorch operation.

Helibase and Helispot Support

- Depending on the complexity of the operation, users may elect to add helibase and helispot management or support positions to include Helibase Manager (HEBM), Helicopter Crewmember (HECM), Aircraft Base Radio Operator (ABRO), or others deemed necessary for the operation. Refer to the NSHO for requirements and duties for those positions. Locations utilizing aerial ignition should have the equipment required for the operation as listed in this guide and the NSHO.

Chapter 3 – Approved Aerial Ignition Devices

All aerial ignition devices must meet Occupational Safety and Health Administration (OSHA) regulations, Department of Transportation (DOT) requirements, and National Fire Protection Association (NFPA) standards as well as the required safety modifications outlined in Chapter 6 – Unmanned Aircraft Systems (UAS) Aerial Ignition, and Appendix C (https://www.nwcg.gov/publications/501).

The following list includes the only aerial ignition devices currently approved for interagency use by all cooperating natural resource agencies. Devices must be updated with current retrofits (Chapter 8 – Reference Materials). IAIU recommends contacting an agency representative prior to equipment purchase:

Plastic Sphere Dispenser (PSD)

- Premo Mark III Aerial Ignition Device
- SEI Red Dragon
- Aerostat PSDS Mark V – no longer manufactured and should be removed from service by 2027
- Raindance R3 Aerial Incendiary Device
- Drone Amplified Ignis Version 2 – see Chapter 6 – Unmanned Aircraft Systems (UAS) Aerial Ignition)

Helitorches and Mix Systems

- Simplex Helitorch Model 5400 and Batch Mixer
- Fire Spec Systems: Spec 2000 Helitorch and Spec 2000 Modular Mix Transfer System – no longer manufactured
- Isolair Helitorch
- Firecon Batchmixer and Portable Mix Transfer System (now GelFire Systems)
- Western Helicraft Helitorch (Barrel Helitorch)
- Northern (Canadian) Helitorch (Barrel Helitorch)
- T&T Helitorch (Barrel Helitorch) – new purchases of T&T equipment are not authorized
- USFS Helitorch M-2015 – contact National Technology and Development Program (NTDP) for engineering specifications

Agency, bureau, or vendor mixing and torch systems that are in compliance with Chapter 8 – Reference Materials and Appendix C (https://www.nwcg.gov/publications/501) criteria, and that have been inspected and approved by a representative of the IAIU may be used. Some aerial ignition devices and procedures are still in use that can only be utilized by a specific agency.

The following aerial ignition device is only approved by specific bureaus and agencies (non-interagency) for burning operations conducted by qualified personnel of the agency approving their use:

- California Division of Forestry (CalFire) Helitorch.

Device manufacturer recommendations for PSD spheres are the only approved fuel sources for approved PSD devices.

Agency Manufactured or Modified Devices

Any modifications to equipment must be approved by the IAIU. If agency personnel modify a commercially obtained device or construct their own device, the agency assumes liability for the product. See Chapter 8 – Reference Materials for current approved modifications.

Manufacturer Modifications

Periodically, manufacturers of aerial ignition equipment modify or upgrade their equipment. Modifications made by the original manufacturer may require special authorization from an agency to be installed.

Bureaus and agencies are not required to install new modifications unless the agency or manufacturer requires installation of the modification for safe operation of the device. All manufacturer modifications shall be accompanied by revised operating procedures if applicable.

For approved current aerial ignition components and modifications, reference Chapter 8 – Reference Materials.

Aerial Ignition Device Approval Process

An agency or bureau may wish to evaluate an aerial ignition system not covered in the NSAI. Natural resource agencies are strongly encouraged to use the devices and procedures approved in NSAI. The following guidelines shall be used for newly proposed aerial ignition system approval:

1. The sponsoring unit must request, in writing, permission to evaluate the unapproved system. The written request shall be submitted through appropriate channels to the regional and state aviation manager.
    a. The written request must include a project proposal, with risk assessment, describing the user needs and justification for use of an unapproved system.
    b. A written manufacturer operational manual must be submitted with the request package describing operating procedures, training plan, and a risk assessment.
2. The agency or bureau aviation manager shall submit the proposal to the IAIU through their representative to the group. The IAIU will then forward the proposal to the aerial ignition technical advisors at NTDP and arrange for technical review and evaluation.
    a. If live burn operations are required as part of the evaluation, the sponsor shall submit an approved agency specific aviation plan: PASP or MASP, and provide necessary personnel that possess the aerial ignition qualifications listed in *Federal Wildland Fire Qualifications Supplement,* https://iqcsweb.nwcg.gov/.
3. After the technical review, the IAIU will submit a letter of recommendation to the Interagency Helicopter Operations Subcommittee (IHOPS) chair. The IHOPS will forward a letter to all agencies and bureaus regarding the decision of new equipment. The IAIU chair will formally notify vendor of IHOPS decision.

Chapter 4 – Plastic Sphere Dispenser Operations

Introduction

The devices were developed to provide a method of igniting ground fuels in a short time on large acreage without causing undue damage to the overstory. This method was required to be cost effective, environmentally acceptable, and readily available.

Description

PSD operations is when a device is mounted in or suspended below a helicopter that expels spheres over a pre-designated area of land with the intent of starting small fires. The operation includes a mission qualified pilot, PLDO, and may include additional firing personnel on board the helicopter. This tool is beneficial for land managers to use in applying fire to landscapes to meet management objectives.

The spheres/capsules are made of plastic and contain a specific amount of potassium permanganate. The rate of chemical reaction is dependent on the particle size and concentration of the chemicals involved. Refer to the manufacturer's recommendations for glycol usage. It provides a reliable ignition and a time delay.

Dispenser Function

The dispenser injects glycol into the plastic sphere/capsule, initiating an exothermic reaction, and then expels the primed sphere/capsule from the aircraft. The device can be regulated to control the number of spheres/capsules being dispensed, establishing ignition patterns on the ground. Power to the dispenser is supplied by the aircraft's 24-volt electrical system. For additional information refer to the appropriate manufacturer's manual.

Safety Considerations

Some helicopter missions are high risk and policy requires that risks shall be mitigated to As Low As Reasonably Practical (ALARP). To obtain ALARP, continued risk mitigation must be conducted by emphasizing thorough pilot and crew briefings, developing CRM, and by communicating ALARP during pilot carding. Altitude, airspeed, aircraft performance, and aircraft limitations should be emphasized during training and operations for all low-level helicopter missions.

The helicopter profile used is at the discretion of the pilot and crew based on mission requirements. Nevertheless, it is highly recommended that the pilot and crew reduce their time in a low altitude environment (below 500 feet), slow forward flight (less than 40 knots), and "hovering out of ground effect" (HOGE) profile. Pilots shall consider escape routes and have the ability to avoid additional risk potential in these flight profiles. Pilots should be prompted utilizing CRM to exit or avoid high risk loss of tail rotor, power settling, and height and velocity (H/V) concerns when it is not necessary to be exposed. The crew remains explicitly empowered to manage or decline the remainder of the flight or mission. It is important to note that aircraft with an H/V diagram (located in the performance section of the helicopter, Rotor Wing Flight Manual) is predicated on an engine failure over a level, hard surface that is clear of any obstacles. The H/V diagram is not intended to provide information over forested, uneven, soft, or otherwise unprepared landing site surfaces.

Performance planning and weight and balance shall be accurately performed.

Consideration should be given to increasing the weight reduction beyond that of policy or contractual standards, ultimately providing excess power to reduce susceptibility of power settling and loss of tail rotor effectiveness.

Reference Forest Service Aviation Accident Prevention Bulletin 16-01
https://www.fs.usda.gov/sites/default/files/2024-01/FSAPB-16-01-Maneuvering-Flight-Power.pdf :

1. Aerial ignition operations may require helicopter flight below 500 feet above ground level (AGL) and less than 50 mph. Exposure to low airspeed, loss of tail rotor effectiveness, power settling, and HOGE is typical of a flight profile. The pilot must keep altitude, airspeed, wind direction, and aircraft capabilities and limitations in mind during all phases of flight operations. Thorough briefings prior to operations are required.
2. All aerial ignition devices must have a means to jettison the flammable components in an emergency (for example, the hopper, capsule bag).
3. The glycol tank must be filled and tightly capped at least 25 feet away from the aircraft.
4. Absolutely no batteries will be carried in the cabin to power the PSD. The PSD must be powered through the aircraft's electrical system.
5. Provide crash rescue and evacuation equipment at helibase/helispot (reference NSHO).
6. A fire extinguisher (reference NSHO, chapter 9) will be available on-site.
7. Extra supplies of glycol will not be carried in the cabin during burning operations.
8. Do not use other containers that cannot be secured inside the helicopter such as plastic bags, tubs, trash cans, cardboard containers, and sphere/capsule bags.
9. A metal container, and at least five gallons of water, will be available during testing for containment of plastic spheres/capsules.
10. Ignition lag time is recommended not to be less than 20 seconds.
    a. CAUTION: An inadequate quantity of ethylene-glycol injected into the plastic sphere can induce a violent reaction that can cause the sphere to spin or roll and spray a hot mixture of potassium permanganate and glycol a considerable distance.
11. During ignition operations, adjust the aircraft speed and altitude according to existing conditions.
12. Do not disassemble any PSD components during flight.
13. Potassium permanganate is a strong oxidizer; it should be stored in a cool, dry place, and must be kept completely separate from glycol. While in transit, spheres/capsules and glycol must be located in separate compartments to eliminate the possibility of inadvertent ignition.
14. The area to be ignited must be clear of people and equipment.
15. The terminology surrounding fall protection systems may seem complex, but it is important to understand the basic systems and terms to choose the fall protection solution best suited for operational mission needs. For example, the terms "fall arrest" and "fall restraint" may at first glance seem indistinguishable and, although both are categorized under the rubric of fall protection, there are important distinctions:
    - A fall arrest occurs after a person free-falls through space. In other words, the system stops a worker's fall that has already occurred, preventing impact at a lower level.
    - A fall restraint system, however, restrains the worker from reaching a fall hazard. In such cases, the fall restraint would typically be provided by a fixed-length lanyard and a body harness or body belt. The lanyard acts as a leash, preventing the worker from reaching the leading edge.

- The primary restraint is considered the seat belt and must be worn at all times. The secondary restraint device may consist of either an approved full body harness or gunner's strap. The PLDO shall wear an approved restraint, tether, and carabiner in the aircraft and must be attached to an approved hard point during firing. The harness, or gunner's strap, and tether must be adjusted to prevent the operator from extending past the plane of the door sill of the aircraft. Additional guidance can be found in the interagency ALSE, https://www.doi.gov/sites/doi.gov/files/uploads/interagency_alse_handbook_v2.8.pdf handbook, in the Aircrew Member Secondary Restraint System section. In addition to ALSE standards, the following are required:
  - Daily inspection of harness, gunner's strap, tether, tether attachment, and carabiner shall be completed. Harness, gunner's strap, tether, and tether attachment shall have a date stamp and will have a life cycle of 10 years after the manufacture date.

Note: Having both feet out the door at the same time is prohibited.

16. Fire shelters for government employees during PSD operations shall be secured and accessible within the aircraft cabin. Fire shelters are not to be located in areas which would reduce the crash extenuation of any aircraft component or restrict the ingress or egress of passengers.

Bench Testing

Bench tests should be performed prior to the actual burn.

1. Review manufacturer's manual and procedures for bench testing.
   a. Bench testing shall occur in an appropriate safe area.
   b. Place metal container under chute/tube without water.
   c. Water in the container has been known to increase the chance of spheres to launch out of the container.
   d. Temperature and humidity may affect ignition delay, causing delays to be greater than 20 seconds. Colder temperatures will cause longer ignitions, often as long as 40 to 60 seconds. This is an appropriate ignition timeframe if all spheres are igniting.
   e. Calibration instructions are contained in manufacturer's manual, if applicable.
   f. Promote priming of the device prior to adding spheres/capsules for testing purposes.
2. Cleaning should follow the bench test in accordance with manufacturer's specifications.

Preparation for Aerial Ignition

Preparation of Helicopter

1. Remove appropriate doors, or open and pin sliding door.
2. Remove all loose cushions and other loose materials.
3. Locate and assure proper electrical connections.
4. Use approved aircraft anchor or install tether attachments to hard points per instructions on MTDC-993 drawing, found in the current ALSE handbook, https://www.doi.gov/sites/doi.gov/files/uploads/interagency_alse_handbook_v2.8.pdf.

5. Install secondary restraint using approved carabiner and adjust tether length. A properly adjusted tether shall ensure that the operator is restrained inside the aircraft if the seat belt should become unbuckled during flight.

Preparation of Aerial Ignition Device

1. Fill the glycol tank at least 25 feet from the aircraft.
2. Fill the emergency water tank.
3. Ensure that an adequate supply of spheres/capsules are available to complete the project.
4. Ensure a one-gallon container of water and seatbelt cutter within reach of the PLDO is on board, secured, and readily accessible.
5. Fire shelters for each occupant must be secured in the cabin of the aircraft and in a singular identified location.

Plastic Sphere Dispenser Installation Procedures (General)

Common Installation Procedures

The dispensing devices are designed to be operated from the rear of most helicopter makes and models.

1. Install in the doorway with the exit chute/tube attached and overhanging.
2. Attach Y-strap.
    a. Y-end attached to PSD beside exit chute, fasten from the inside out.
    b. Connect and tighten the Y-strap ensuring it is secured and does not interfere with any external fittings, wiring, or release cables.
    c. All helicopters may use Y-strap, approved model specific hard points, or an adapter plate or mounting brackets to secure the device. Requirements include Federal Aviation Administration (FAA) approval documents to support installation, or approval of installation methods not covered by the manufacturer's recommendations for use by each agency.
    d. Return through the opposite door.
    e. Fasten to buckle attached to device.
    f. Cinch tight and secure loose ends.
3. Connect power supply cord.
4. Perform electrical power check by turning on drive switch and hopper feed switch. Manual assist must rotate in direction of arrow. For the Raindance system, perform electrical power check by turning on the device and ensure the carousel turns counterclockwise.
5. Recheck the installation.
6. Ensure a seat belt cutter is attached to and accessible by the PLDO.

Installation of the PSD will be specific to individual helicopter models. Model specific procedures are outlined in a job aid. Consult the manufacturer installation procedures for those helicopters not listed in this guide.

The Following Applies to All PSD Installations:

1. The PLDO must read the operator's manual before installation.
2. The PLDO and the pilot must read the limitations section of the flight manual and be familiar with the limitation of flight with the door(s) removed.
3. Helicopters shall be equipped with a power source for PSD.
4. A MS3112E–12-3S, 3-pin connector shall be provided. Pin B shall be airframe ground. Pin A shall be +28 volts DC for a 28-volt aircraft system. Pin C shall be +14 for a 14-volt aircraft system. The circuit shall be protected by a 5-amp circuit breaker. The mating connector for the government-furnished PSD shall be an MS3116E-12-3P wired with the same pin assignments. Reference a wiring diagram in the aircraft procurement document.
5. Unit weights can be found in manufacturer specifications.
6. The mounting area must be cleaned, which includes vacuuming if there is powder from broken spheres and cleaning any glycol that may have spilled on the floor from previous installation. All carpet and porous floor coverings must be removed.
7. A one-gallon container of water and a seat belt cutter must be carried on board and be secured and readily accessible to the PLDO.
8. Fire shelters for each occupant must be secured in the cabin of the aircraft and located in a singular identified location.

PSD Installation Procedures for Specific Helicopter Types

Listed below are installation procedures for common aircraft used for PSD operations. Any helicopter may be used if it is carded and agency-approved for PSD operations. Refer to aircraft flight manual for door removal and limitations. Adapter plate and chute extension may be used but are not required.

Aircraft with a Doorsill such as: Bell 206 and 407 Series Helicopters

1. Remove right rear door of the helicopter.
2. Use padding or other means to protect the paint finish around the right rear doorsill (consult with pilot or vendor before doing this).
3. Place the PSD mainframe over the doorsill and connect the Y-end buckles of the Y-strap to the slots in the mainframe. Do not tighten the hold-down strap.
4. Install an exit chute. Tighten and lock nuts.
5. Install hopper on the mainframe and make electrical hookup between units.
6. Slide the assembled PSD as far forward as possible to provide legroom between the device and rear seat. Some helicopters have a cabin fire extinguisher mounted on the rear of the pilot's seat and it may interfere with the opening of the hopper lid. The device must be slid far enough aft to allow the hopper lid to open, ensuring there is enough room to access the PSD control panel.
7. Connect and tighten the belly hold-down strap making sure the strap is secure and does not interfere with any external fittings, wiring, or release cables.
8. Make sure the PSD switches are in the OFF position and connect the power supply plug from the helicopter to the PSD.

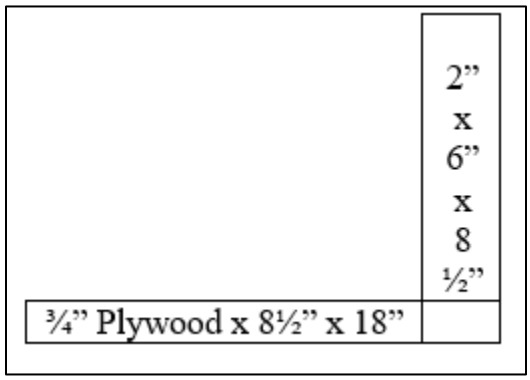
9. A metal container shall be placed under the exit chute at this time to catch any spheres that may be triggered from the PSD during the polarity check.
10. Turn the PSD on and watch the rotation of the hand-wheel. Rotation in the direction of the arrow indicates correct polarity. To change the direction of rotation, reverse the plug wiring on the PSD (black wire is positive, and the white wire grounds the chassis).
11. Proceed with ignition timing tests, briefings, and other precautionary protocol.
12. Manufacturers' safety precautions must be adhered to during operation of the PSD.

Flat or Level Cabin Floors such as: Hughes/MD 500 Series, AS-350, and UH-1H Helicopters

1. An extension may need to be added to the Y-strap when using this type of helicopter (AS-350, UH-1H). The extension must be added to the short buckle portion that is attached to the PSD. The smooth, flat portion of the strap must pass through the closed doorframe without hanging up.
2. An approved, hard point secured attachment system may be used for all aircraft.
3. An adapter board may need to be constructed to mount the PSD in flat or level cabin floor helicopters (see Figure 3.1).
4. Remove or slide open and lock the right rear door of helicopter.
5. Use padding or other means to protect the paint finish around the right rear doorsill (consult with pilot).
6. Place the adapter, if needed, on the floor and the PSD mainframe on the adapter and connect the Y-end clips of the strap to the slots in the mainframe. Do not tighten the hold-down strap.
7. Install an exit chute. Tighten and lock nuts.
8. Install the hopper on the mainframe and make electrical hookup between the two units.
9. Slide the assembled PSD as far forward as possible to provide legroom between device and rear seat. The fire extinguisher may need to be removed from its holder and secured on the floor, or the device must be slid far enough aft to allow the hopper lid to open. Either option must ensure enough room for access to the PSD control panel on the side of the mainframe.
10. Connect and tighten the Y-strap or approved, hard point secured, attachment system ensuring it is secured and does not interfere with any external fittings, wiring, or release cables.
11. Make sure the PSD switches are in the OFF position and connect the power supply plug from the helicopter to the PSD.
12. A metal container shall be placed under the exit chute at this time to catch any spheres that may be triggered from the PSD during the polarity check.
13. Turn the PSD on and watch the rotation of the wheel. Rotation in the direction of the arrow with the Premo PSD indicates correct polarity. To change the direction of rotation, reverse the plug wiring on the PSD (black wire is positive and the white wire grounds the chassis).
14. Proceed with ignition timing tests, briefings, etc.
15. Manufacturer's safety precautions must be adhered to during operation of the PSD.

Adapter plate example: construction is of 1/8-inch welded aluminum or on a 3/4-inch plywood base.

Figure 1. Adapter Plate Example



Raindance Installation Procedures for Specific Helicopter Types

See manufacturer's manual.

Preflight Test Procedures

Sphere/capsule ignition delay time need not be checked in the preflight test if bench test has been performed. Test Procedures 7, 8, 9, and 10 are not required if bench test has been completed prior.

Caution: Do not conduct this test near refueling area or in flashy ground fuels.

Preflight Test Procedures Are as Follows:

1. Connect power leads.
2. Power on – A/C.
3. Power on device and hopper.
4. Turn glycol on and test speeds.
5. Check for slipper block movement through manual assist wheel.
6. Test emergency water system.
7. For PSD, deposit one sphere in a slipper block or shuttle block to track calibration.
8. Once the sphere/capsule has dropped into the metal container, remove it from the vicinity of the aircraft.
9. Time ignition delay by measuring time of injection to ignition.
10. Repeat as necessary.
11. Check system for leaks.
12. Secure device and equipment.
13. For PSD, fill hopper with spheres.
14. Check intercom communications and air-to-ground communications.

Pre-Mission Briefing

Perform briefing prior to conducting mission operations by using the briefing checklist in Appendix A, with an emphasis on covering the risk assessment and mitigations, emergency procedures, helicopter performance capabilities, and flight profiles.

Prior to a burn mission, the HMGB must brief all personnel involved as to the nature of the mission and its objectives, through the use of PASP or MASP. The information should include known environmental concerns such as weather and fire behavior, individual responsibilities, incident specific information such as location (for example, division assignment), radio frequencies, name of communication center, and any other incident specific information.

Prior to any burn operation, the pilot and manager will identify any performance limitations for the aircraft and determine excess performance required for the mission. Consideration should be given to increasing the weight reduction beyond that of policy or contractual weight reduction standards to reduce susceptibility to loss of tail rotor effectiveness and power settling. Performance should be planned so that the mission is carried out within the maximum continuous power of the helicopter.

Weight and balance calculations will be performed for standard burn configurations and emergency scenarios prior to the commencement of burn operations. The purpose is to ensure the center of gravity will remain within limits.

In-Flight Operations

Ignition Operations

The aerial ignition supervisor gives the location where spheres are to be placed in the burn area. This should be made clear during the dry run before any firing begins. It is important that all parties (aerial ignition supervisor, pilot, and PLDO) understand where the firing is to be performed. This includes starting points, ending points, desired placement, and spacing.

During ignition operations, adjust the aircraft speed and altitude according to existing conditions. The pilot and aerial ignition supervisor must keep altitude, airspeed, wind direction, and aircraft capabilities and limitations in mind during all phases of flight operations. Thorough briefings prior to operations are required.

The aerial ignition supervisor gives direction to the pilot once the firing run has begun and during the dry run to assure correct placement of the injected spheres.

Occupants of the helicopter shall be limited to essential personnel. Additional occupants may include instructor or trainees if essential to the mission.

The switches on the PSD are not required to be turned off when the PSD helicopter stays within the burn area boundary or crosses a fire control line with the intent of returning for another live firing run. The operator’s right hand must remain on the feed control levers in the closed position. If leaving the burn area, the device must be completely shut off and deactivated.

Dry Run over Burn Area Procedures

Before starting burn operations, a HOGE power check is accomplished at an altitude comparable to the burn area or greater. A positive rate of climb must be established without exceeding aircraft limitations. The pilot is responsible to ensure sufficient power is available by performing a HOGE power check prior to any landing site approach or departure. Refer to the Interagency Aviation Tech Bulletin (IATB) 17-01 25, https://www.doi.gov/sites/doi.gov/files/uploads/iatb_2017-01.pdf.

1. Identify burn area boundaries.
2. Identify helispots and emergency landing areas.
3. Ensure communication with ground personnel.
4. Make a practice run of the first firing sequence.
5. Coordinate device speed and sphere/capsule spacing to be used on first run with FIRB.
6. After a dry run and prior to aerial firing, the crew will evaluate the risk assessment mitigations and readjust as necessary (this does not require formal documentation). The aerial ignition supervisor will confirm that all ground personnel are clear of the area and that firing may commence.

In-Flight Procedures (Using Example of FIRB as Aerial Ignition Supervisor)

FIRB Communicates to PLDO, "Prepare to Fire; Activate Device."

1. Operator actions:
   a. Activate device;
   b. PLDO communicates to FIRB, "Ready to fire."
2. FIRB communicates to PLDO, "Start firing/number of chutes or device speed" (for example, "Start firing, 2 chutes on fast").
3. PLDO replies, "Firing/Number of chutes or device speed" (for example, "Copy, Firing, 2 chutes on fast").
4. Operator monitors device operation and refills as needed. Operator observes spheres/capsules after they have made contact with the ground to confirm ignition.
5. When appropriate, FIRB communicates, "Prepare to stop firing."
6. PLDO places hand on controls and communicates, "Ready to stop."
7. FIRB gives the order, "Stop firing."
8. Operator closes chutes on PSD or presses stop button on Raindance and responds, "Firing stopped."
9. Operator observes last sphere/capsule clear of the device and relays, "Device cleared."
10. FIRB gives order to PLDO to "Secure device" or "Prepare to fire."
11. Operator gives appropriate response of "Device is secure" or "Ready to Fire."
12. Conduct a post mission debriefing that includes a review and update of hazards and risk mitigations.

Transportation and Safety Data Sheets (SDS)

See manufacturer documentation and Safety Data Sheets (SDS) in Chapter 8 – Reference Materials.

Manufacturer states that the spheres have an indefinite shelf life; they have tested spheres that have been in storage for 20 years with favorable results. The main environmental effects that can cause problems are humidity, extreme temperature variations, and exposure to ultraviolet light. Discoloration of the sphere is a sign of exposure to moisture, which causes the potassium permanganate to cling to the sides. This does not necessarily mean that the spheres won't function properly. Old spheres that are brittle may still be acceptable for use. Anticipate a dirty device. The more brittle the spheres become the more apt the device is to jam. Poor ignition of spheres is generally caused by over-injection of glycol. Bench testing prior to use will give indications of sphere condition (brittleness).

The manufacturer recommends following local hazardous materials protocol for disposal of spheres. There is not a manufacturer sponsored recycling program for spheres.

Storage procedures: Follow manufacturer's recommendations, or local agency and bureau procedures.

Chapter 5 – Helitorch Operations

Introduction

The helitorch is a gelled fuel aerial ignition device that is attached to a helicopter's external cargo hook. The ignition and fuel feed are controlled by the pilot through a simple electrical connector on the belly of the helicopter, usually the water bucket plug. The complete system is able to be jettisoned by the pilot in case of emergency.

Description

Adding fuel-thickening compounds to raw fuel reduces the volatility and is therefore more manageable for dispersal. This improves the safety of handling the fuel, improves its drop characteristics, puts more fuel onto the ground (rather than burning off in the air), and increases residual burning time allowing the aircraft to be flown higher and faster than some other aerial ignition systems.

Function

This aerial ignition device is a tool used in backfiring and burnout operations for wildfires and is common in prescribed fire operations to reduce hazard fuels. It is a very effective tool but must be used by very skilled, qualified pilots and trained qualified field personnel for a safe operation.

Helitorch Mixing and Loading Area

CAUTION: All handheld electronic devices such as radios, pagers, cell phones, and satellite phones shall be turned off within 50 feet of any fuel preparation or vapor removal area. This prohibition will be emphasized as part of each daily briefing and each risk assessment. Warning signs should be posted.

Safety

- The location and layout of the fuel mixing and helitorch loading site is critical to reducing the risk of accidents with flammable materials, helicopter, and mixing and loading personnel. The fuel mixing and loading area is used for the purpose of blending the fuel and gelling agent, exchanging drums on helitorches, or refilling drums from the mixing units.
- The helitorch base should be separated from the primary helibase and other helicopter operations. No smoking is permitted within the mixing and loading area. Precautions must be taken to eliminate sources of ignition where fuel vapors may be present.
- Each helipad requires a fire extinguisher, per NSHO, Chapter 9. https://www.nwcg.gov/publications/pms510
- Fire protection for helitorch operations must have one of the following (in addition to one fire extinguisher per pad, required per NSHO, Chapter 9):
  - A minimum of four extinguishers.
  - Two 3-gallon compressed air foam system extinguishers capable of using Class B foam.
  - Staffed 30-gallon Class B foam capable system.
  - Staffed engine with Class B foam on-site.

Location

The helitorch mixing and loading area should meet the following criteria:

- The helitorch site should be large enough to accommodate and provide a safe working distance between all the required pieces of equipment.
- The site should have an established takeoff and landing corridor that has no equipment placed within that zone.
- A safety circle shall be maintained around the landing pad.
- There should be an alternate loading area in case the mixing and loading site becomes unusable.
- The site should be located in close proximity to the burn site to minimize turnaround times.
- Choose a site that will not be impacted by the smoke column or embers from the burn.
- Consider the prevailing and forecasted wind direction. Keep location upwind of the burn.
- Helicopter flight paths must not pass over any personnel, structures, or areas of human occupancy. When over-flights of traveled roads occur, traffic control must be mitigated.
- The helitorch operation site should be reserved for authorized personnel only.
- Establish alternate landing areas.
- During wildland fire incidents, helitorch base operations should be separated from the primary helibase.
- Choose a site that has no need (or a minimal need) for dust abatement.
- Mixing equipment must be located outside the helicopter safety circle.

Fuel Preparation

For all fuel preparation activities, refer to Chapter 8 – Reference Materials.

Safety

- The HTMG must be aware of the procedures for safe storage, handling, and mixing of fuel according to agency or bureau policies.
- The mixing area should be large enough to accommodate and provide a safe working distance between all required equipment.
- Nonferrous mixing equipment must be used and all bonding procedures must be followed.
- Ensure precautions are exercised to eliminate direct exposure of skin to the gelling agent or fuel, including wearing gloves and goggles.
- When dispensing or handling powdered gelling agent, if dust masks are provided for voluntary use (as defined by OSHA in 29 CFR 1910.134 https://www.osha.gov/laws-regs/regulations/standardnumber/1910/1910.134), ensure the following:
    - An N-95 dust mask is supplied.
    - Prevent contamination of N-95 dust masks by storing in a chemical and dust free sealed container to ensure their use does not present a health hazard.

- Wearing the N-95 dust mask does not interfere with employees' ability to work safely.
- Instruct employees that the N-95 masks are for one-time use and a new one should be used each day.
- Supply, and ensure each employee reads a copy of, Appendix D of 29 CFR 1910.134, which instructs employees on N-95 dust mask limitations such as warning them that wearing a dust mask does not protect them from organic vapors.
- For employees using respirators, refer to Appendix D of OSHA regulation, Sec. 1910.134.

- If gelled fuel is spilled, burning the gelled fuel on-site is the preferred method of clean-up, if possible.
- Consult with a local safety officer prior to performing cleaning or maintenance on the interior of batch or modular mixers as well as prior to the cleaning up of spills to determine the appropriate respiratory protection and other personal protective equipment (PPE).
- Personal protective equipment: Personnel must be equipped with eye protection, hardhat, fire resistant clothing labeled as non-static (clothing must be labeled with Nomex ® IIIA or 2 percent carbon core or 3 percent conductive fiber) or 100 percent cotton, and nitrile chemical resistant gloves. Testing performed at the University of Alberta has shown clothing that consists of these fabrics have better anti-static properties than cotton.
- "No smoking" and "No cell phones or radio" signs conspicuously posted around mixing area, to include all vapor removal outlets.

When Not Required to Wear a Respirator Under the OSHA Standard

Respirators are an effective method of protection against designated hazards when properly selected and worn. Respirator use is encouraged, even when exposures are below the limit, to provide an additional level of comfort and protection for workers. However, if a respirator is used improperly or not kept clean, the respirator itself can become a hazard to the wearer. Sometimes, workers may wear respirators to avoid exposures to hazards, even if the amount of hazardous substance does not exceed the limits set by OSHA standards. If an employer provides respirators for voluntary use, or if individuals own their respirator, the individual needs to take certain precautions to be sure that the respirator itself does not present a hazard.

Personnel should do the following:

- Read and follow all instructions provided by the manufacturer on use, maintenance, clean, care, and warnings regarding the respirator's limitations.
- Choose respirators certified for use to protect against the contaminant of concern. The National Institute for Occupational Safety and Health (NIOSH) of the U.S. Department of Health and Human Services, certifies respirators. A label or statement of certification should appear on the respirator or respirator packaging. It will tell what the respirator is designed for and how much it will protect a person.
- Do not wear a respirator into atmospheres containing contaminants for which the respirator is not designed to protect against. For example, a respirator designed to filter dust particles will not protect against gases, vapors, or very small solid particles of fumes or smoke.
- Keep track of your respirator so that you do not mistakenly use someone else's respirator. Reference 63 FR 1152, https://www.govinfo.gov/app/details/FR-1998-01-08/97-33843.

Hazards

- Gasoline vapors are a depressant to the nervous system and a known carcinogen; prolonged and direct exposure to these vapors must be avoided.
- Personnel should keep their hands out of gasoline and fuel mixtures. Special care must be taken to keep fuel from the mouth, eyes, open cuts, and abrasions.
- Dust created in fuel mixing should be avoided. Mixing can only take place when all personnel involved in the operation are adequately trained and equipped.
- Hazards to the mixing personnel include vapors and flammability of gasoline, skin contact with fuel, and dust from the gelling agent. Review Chapter 8 – Safety Data Sheets (SDS).

Handling Gelling Agent and Fuel

- Bulk transportation of fuel is recommended whenever possible using a fuel truck with its own pumping system.
- When bulk fuel transportation is unavailable, a portable refueling system may be used that complies with requirements in Chapter 8 – Reference Materials.
- The powdered gelling agent must be kept dry.
- All gelling agents shall be disposed of in accordance with applicable state and federal regulations.
- Reference the Department of Transportation regulations for specific requirements related to the transportation of gelling agent and fuel: Chapter 8 – Reference Materials.
- Only gelling agents with a current SDS are approved for use. Current approved brand names for thickeners are: Firetrol Firegel (also known as Sure Fire), Firetrol Petro Gel, Flash 21, and Halliburton MO85 and MO86.
- Portable eyewash station required on-site. OSHA 1910.151 and 1926.5 requires that when the eyes may be exposed to injurious corrosive materials, suitable facilities for the quick drenching or flushing of the eyes shall be provided for immediate emergency use. The American National Standards Institute (ANSI) recommends 15-minute continuous flow.

Mixing Procedures

- Correct mixing is essential and clean fuel results in the best gelling and ignition. The optimum fuel temperature for gelling is 21 degrees Celsius or 70 degrees Fahrenheit. Colder fuel takes longer to gel and requires more gelling agent for a proper mix.
- Cleanliness of fuel, gelling agent, and equipment must be ensured. It is desirable to set up the mixing area well ahead of the desired ignition time to ensure all components of the setup are operational.
- HTMG checks to ensure all personnel are properly equipped and that all safety gear is in place.
- All drums and associated equipment must be clean.
- HTMM ensures all mixing systems, helitorches, and bulk fuel sources are properly bonded. Reference Chapter 2 – Aerial Ignition Position Qualifications.

1. Mix-crew attaches the bonding cable and fuel nozzle to the mixing unit and adds fuel.
2. After fueling, the HTMM adds the measured amount of gelling agent to the mixing unit while the fuel is being agitated. Gelling agent must be added slowly or improper gelling may occur.
3. Mixing of fuel and gelling agent continues until required amounts have been added (reference manufacturer's mixing guidelines). Agitation continues until complete mixing has occurred and the mixture shows signs of gelling (waxy surface and thickening).
4. The HTMM determines if the gel is of the desired consistency.
5. Powdered gelling agent added to partially gelled fuel will not totally dissolve and may cause lumping.
6. Ensure proper gel consistency before pumping to helitorch. Gel color may vary with different grades and brands of fuel. Gelling quality may be affected by additives such as ethanol and detergents. The use of liquid gelling agents will have different procedures, so follow the manufacturer's instructions.
7. No plastics of any kind shall be used in the powdered gel mixing operations. All dispensing equipment must be made of metal capable of being bonded. Do not pour powder gelling agent directly from the bag into the drum or tank (NFPA 77, 8-11).
8. Fuel that has been gelled with powder should not be mixed unless its use is likely. This mix, which has been gelled for more than 2 hours, will begin to lose viscosity and may cause flaring during use.

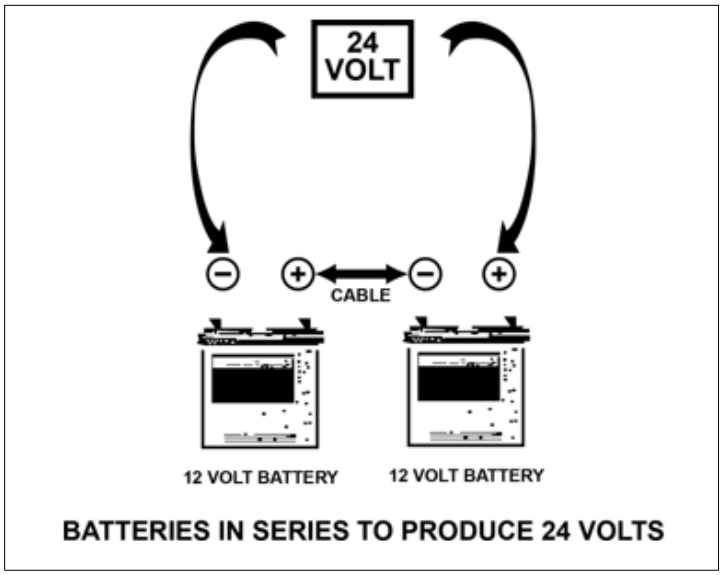
Bench Testing the Helitorch

Helitorches will be kept clean and maintained to avoid operational delays. Once the helitorch has been cleaned and reassembled, it can be tested for serviceability on the ground. A fire extinguisher (per NSHO, Chapter 9, https://www.nwcg.gov/publications/pms510) must be readily available for use by a trained person during helitorch testing procedure. The helitorch will not be loaded with gelled fuel for bench testing.

Bench Test Steps

1. Connect two 12-volt batteries in series to produce 24 volts. See Figure 2 or use a power converter.
2. Ensure that both pumps and ignition switches are in the off position. Attach the power cord to the battery and the 9-pin plug to the helitorch.
3. With the ignition switch on and the pump switch off, check to see that the igniter is producing a spark. Adjust propane flow as needed, if equipped.
4. With the pump switch on and the igniter switch off, check to see that the motor and pump operate normally and the pulley, if equipped, rotates in the proper direction— clockwise when viewed from the control switch side of the helitorch.
5. Turn both switches off and disconnect the plug from the battery adapter cord.
6. Check all nuts, bolts, and connectors for tightness and serviceability.

Figure 2. Batteries in Series to Produce 24 Volts



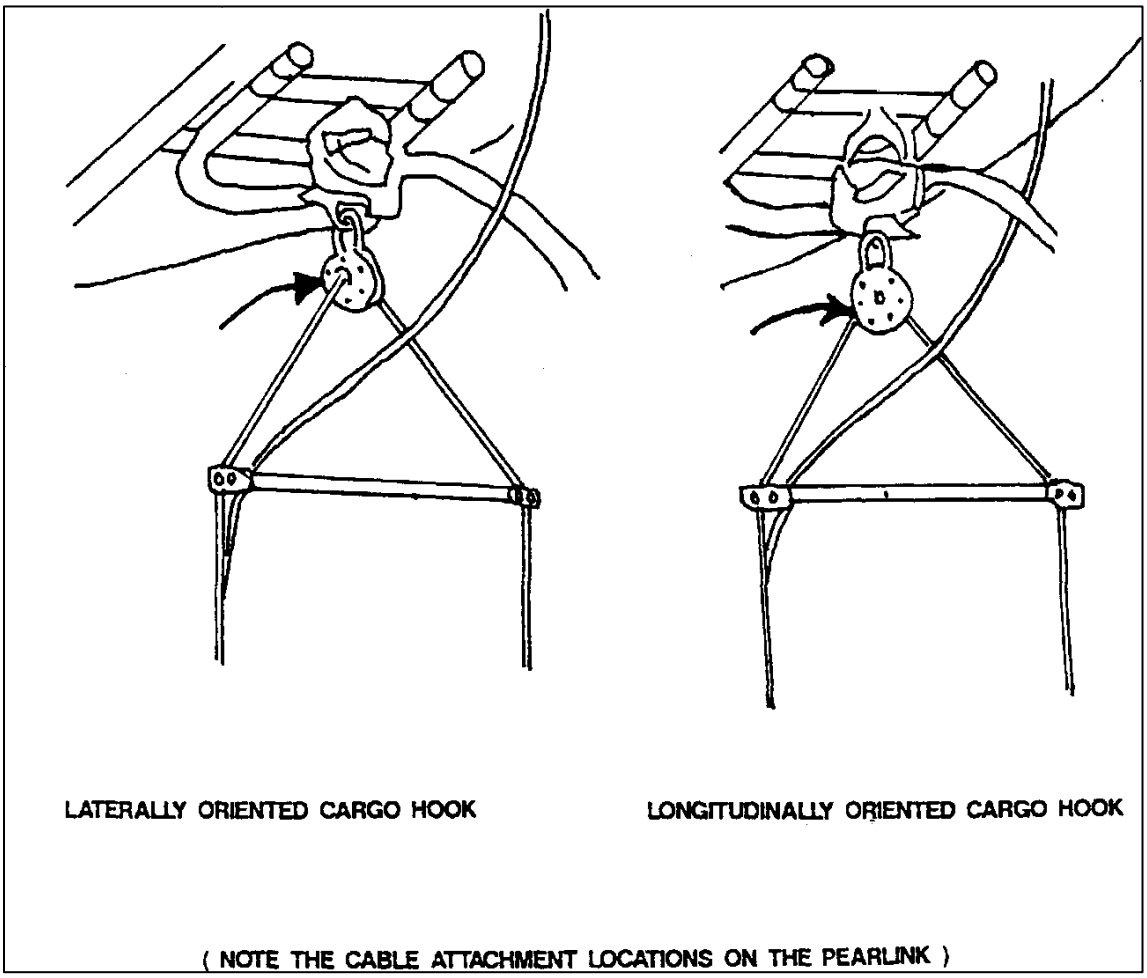
Helitorch Installation to Aircraft

1. Remove the pilot door.
2. Ensure that the suspension cables are correctly installed to the helitorch (See Figure 3). Inspect cables and connectors for security. Suspensions of up to 50-feet are permitted.
3. Place the helitorch on the ground in front of the helicopter with the nozzle end to the pilot's side of the aircraft and make sure the switches are off. Ensure lines are not over or under landing gear.

Figure 3. Location of Attachment Points of Single Point Cable Assembly

4. Ensure that the pear link adapter is correctly configured for the cargo hook on the helicopter. (See Figure 3 to make sure that the cables are between the skids and will not become entangled during takeoff. Conduct a safety check of the cargo hook, both manual and electrical releases. Attach the pear link to the cargo hook. After ensuring that both switches are in the off position, secure the electrical cannon plug to the plug on the helicopter.
5. Due to the length of the cables, care must be taken when landing medium helicopters.
6. For use with medium helicopters, ensure hook is secured and pinned to the trolley so the helitorch is not able to rotate or discharge static electricity that may arc by touching the side of the trolley.

Figure 4. Laterally Oriented Cargo Hook and Longitudinally Oriented Cargo Hook



7. Before testing helitorch with the helicopter, disconnect pear link from the aircraft cargo hook. Failure to follow this procedure can result in damage to the helicopter wiring if polarity is incorrect.
8. The helitorch suspension system shall be hooked directly to the helicopter cargo hook. Tag lines, lead lines, or longlines are prohibited.

Testing Helitorch with Helicopter

After the helitorch has been bench tested, it shall be tested with the helicopter while both are on the ground. At this point it is essential that you have conducted a pre-operational briefing with the pilot and crew.

This briefing must include communications, any identified hazards, and associated mitigations, aircraft performance, and emergency procedures. Ensure the desired nozzle tip is installed on the helitorch, that there are no cables over the skids, and have a fire extinguisher staffed with a trained person.

Ignition Test

1. Disconnect pear link.
2. Ensure the pump switch is off and turn the ignitor switch on.
3. Have pilot activate the helitorch control switch to test for proper ignition.
4. Have pilot release helitorch control switch and turn ignitor switch off.
5. Allow tip to cool prior to pump test.

Pump Test

1. Check dry-break connection and open hose valve.
2. Ensure ignition switch is off and turn pump switch on.
3. Place fuel catch vessel under fuel nozzle.
4. Have pilot activate the helitorch control switch. Gelled fuel should flow through the nozzle tip. At this time, all lines should be bled to ensure fuel flow. If you hear the motor turning with no fuel flowing, check for clogging, vapor lock, or polarity reversal. If the polarity is reversed, simply reverse the input wires or use a backward wired pigtail. When polarity is correct, reconnect pear link to the aircraft cargo hook.
5. Check that the nozzle plunger does not allow fuel to leak from the nozzle and that it operates freely.
6. Make sure both switches are off.
7. The torch is ready for operation.

Filling Helitorch from Mixing Unit

Ensure all mixing systems, helitorches, and bulk fuel sources are properly bonded. See Chapter 6 – Bonding Procedures:

1. The helicopter returns with an empty drum. The HTPT directs the helicopter to its landing position.
2. Once the helicopter is on the ground, the pilot signals to the HTMM or designee to approach.
3. The HTMM or designee turns the switches off. HTMM or designee now connects the vapor recovery and filler hoses on the helitorch drum. The HTMM or designee signals to the mixing plant to pump gel. When the drum is full, the HTMM or designee signals to shut off the mixing plant pump. Then the HTMM or designee closes the valve, removes fuel and vapor hoses, turns the switches on, and exits. After fueling is complete, change propane bottle, if applicable, and test ignition.
4. The HTPT performs visual final checks that ensures switches are on, cables are correct, dry-break handle is in the open position, propane gauge is in an acceptable range, and nozzle tip is clean. The HTPT then exits.

Prior to Each Takeoff (Final Check)

1. Ensure that the pear link adapter is correctly configured for the cargo hook on the helicopter and attached to the cargo hook. Check helitorch structural integrity.
2. Igniter is clean.
3. Helitorch and suspension system is positioned in front of the helicopter with the nozzle end toward the pilot's side of the aircraft.
4. The HTMM or HTPT will inform the pilot prior to activating switches. Activate pump and ignition switches and exit the area toward the HTPT.
5. At no time should there be anyone underneath or in close proximity of the helicopter with the helitorch attached while in flight.
6. HTPT directs takeoff.

Cleaning and Maintenance of Helitorch and Related Equipment

The helitorch, drums, and mixing unit must have proper maintenance to be dependable. Thoroughly flush all equipment with diesel fuel and run through all nozzles and hoses. Keep all equipment indoors or cover well. Routine inspection of equipment should occur even during times of non-use to prevent corrosive damage.

Helitorch Maintenance

Obtain major component service and maintenance publications from manufacturers and distributors.

1. Flush the helitorch plumbing with diesel fuel or Jet A after each operational period.
2. Clean ignitor system.
3. Clean and inspect discharge nozzle assembly.
4. Inspect hoses and electrical wiring.
5. Complete required maintenance checklist and helitorch use record as indicated in Appendix B (https://www.nwcg.gov/publications/501).

General Mixing System Maintenance

1. Mixing systems that meet MC 306 or DOT 406 design specifications must comply with DOT regulations. This includes an annual external visual inspection and leakage test. An internal inspection and pressure test must be performed every 5 years. The tests must be performed by a DOT licensed inspector.
2. Inspect and maintain the mixing system trailer brakes, wheel bearings, electrical system, engine oil, air filter, spark arrester, as well as the general integrity of the unit on an annual basis. Record and log all work performed.
3. Reference maintenance publications for the major components of the mixing system (for example, engine, pump, and valves) to maintain the equipment and to help remedy any problems that arise when troubleshooting). Report any problems to your agency representative of the IAIU. See the roster for the NWCG unit to locate a contact.

4. Clean and purge the mixing system tank, plumbing, suction line, and discharge lines of gel and fuel when the unit is not operated for a prolonged period.
    a. Pump as much of the remaining gel out of the plumbing and tank. Use a nonferrous metal or wood paddle to scrape gel toward outlet valve if needed.
    b. Put several gallons of diesel into the tank and recirculate. Flush all hoses with diesel.
    c. Purge the entire system of diesel.
    d. Fuel remaining in the system can absorb moisture and could jeopardize the life span of the tank by pitting and rusting the internal walls. Moisture can degrade gel consistency rendering it unsafe.
5. Care must always be taken not to introduce foreign matter (such as rocks, grit, and debris) from getting into the system and damaging the pump or valves.
6. Prevent rust from forming on the tank. Paint the unit when necessary.
7. Keep the mixing system clean and store in a dry place.

Drum and Associated Hardware Maintenance

- Keep the drum purged of gel and fuel when not in use.
- Prevent rust from forming on the drum. Paint if necessary.
- Keep the drums clean and store in a dry environment.
- Keep the dry breaks clean of dirt, debris, and gel residue.
- Keep Clay & Bailey relief valve, site glasses, as well as vapor removal and recovery camlock free of gel residue.
- Clean and lubricate all components with a minimal amount of diesel prior to storage.

Vapor Hose Maintenance

- Store hoses in dry location away from sunlight.
- Ensure that debris does not enter the hose by keeping the camlock caps on during storage.
- Perform continuity test prior to use.
- Replace brittle, dry, or cracked hoses.

Helitorch and Mix Transfer System Required Modifications and Approved Equipment Inspection Checklists

See Appendix C (https://www.nwcg.gov/publications/501).

Barrel Helitorch Assembly and Setup

Figure 5. Barrel Helitorch

Helitorch Assembly

1. Unwind the cables for the spreader bar assembly.
2. Straighten and check the suspension lines for damage and entanglements.
3. Check all connections to ensure they are secure and properly wired for safety.
4. Remove the two bolts from the sleeve portion of the bent leg frame.
5. Install the straight frame into the sleeve portion of the bent leg and secure it with the bolts, nuts, and safety pins.

Gelled Fuel Helitorch Setup Procedure

Mixing helitorch components between kits may cause compatibility problems due to differences in hose or nozzle length. If 1 1/2-inch hose lengths are too long, the drum clamp may disconnect in flight.

1. The pump-fin assembly is quick-pinned into place in the slot on the down facing side of the straight leg frame, below the ignition box.
2. One end of the 3/4-inch hose fitting is connected to the outlet of the fuel pump. The other end is connected to the fuel nozzle inlet on the bent leg frame.
3. The 1 1/2-inch fitting will attach to the 1 1/2-inch coupler installed on the fuel drum.
4. The cannon plug on the pump assembly presses onto the receptacle on the ignition box.

Adjusting the Igniter Tip

1. Igniter wire and nozzle terminus should be free of carbon deposits. Remove carbon deposits with sandpaper or a wire brush.
2. When properly adjusted, the igniter wire bends at the nozzle tip and parallels the nozzle terminus so that a gap of approximately 1/4-inch to 3/8-inch exists between the two. This will allow multiple points for arcing to occur and prevent ignition failure.

Fuel Drum Valve Assembly

Figure 6. Fuel Drum Valve Assembly

The Barrel Helitorch uses unmodified standard 55-gallon fuel drums. The ground crew must check the drums for fuel leaks and bent rims. Drums with bent rims on the vent bung side of the drum, or large dents in the side of the drum near drum rims, cannot be used since this is the area where the drum attaches to the helitorch. Any drum with damaged threads should not be used because it may leak or damage the threads of the helitorch vent or helitorch coupler.

1. Install small brass bleed-vent in the drum bung.
2. Ensure drum rim height and rim thickness is compatible with torch frame to maintain positive lock with torch.
3. Check the bleed-vent for proper operation before installing by gently blowing on the brass end of the vent. If air does not go through the vent, or the vent is too loose, adjust the vent by tightening or loosening the vent's inset screw, which is located inside the vent.
4. The bleed-vent also serves as a check valve. If it is adjusted too loosely, fuel will leak from the vent during flight. Use a bung plug gasket on the air vent and finger-tighten to the drum.
5. The 1 1/2-inch coupler is used for gelled fuels.
6. Fuel must be gelled before inserting drum coupler.
7. Put Polytetrafluoroethylene (PTFE) tape (yellow petroleum Teflon tape) on the coupling valve to seal threads. Do not use the bung gasket with the coupler.
8. Close the coupler valve before inserting into the drum.
9. Use a pipe wrench attached to large bung adapter to tighten the coupler to the drum. Do not use the coupler handle.
10. The coupler closure handle should face up toward the center of the drum after the coupler is tightened.
11. Keep drums upright until ready for use.

Initial Helitorch Hookup

1. Ensure the fuel drum coupler valve is closed, then place the drum on its side so that the small bung valve is in the upper most position and the fuel coupler is in the lowest position.
2. Place the helitorch on the ground in front of the helicopter.
3. Orient nozzle terminus toward the pilot's side.
4. Helitorch should be placed close enough so that it can be hooked to the aircraft by a person crawling underneath the aircraft, and far enough away to minimize cable slack.
5. Attach the pear link to the aircraft cargo hook.
6. Attach the helitorch electrical connection to the helicopter's external electrical plug.
7. Check the aircraft manual and electrical hook release to ensure that the helitorch can be jettisoned during an emergency.
8. Open fuel valve on drum to half open.
9. Turn on both ignition and fuel switches on the helitorch as well as the manual valves for the Mapp and propane gas.
10. During lift-off, ensure that suspension lines do not become entangled with the helitorch and are not draped over the helicopter skid.

Drum Exchanges for Barrel Helitorches

1. A full fuel drum with coupler and bleed air vent attached is elevated to facilitate drum exchanges.
2. The parking tender directs the helicopter to lower the helitorch onto the downwind side next to the full drum, ensuring that the helitorch tip does not touch the ground.
3. As the helicopter is landing, the parking tender will direct the pilot back so the cables on the torch remain slack free. The HTMM turns off the ignition and pump switches, closes the inline Mapp and propane gas valve, and turns off the fuel valve on the 1 1/2-inch drum coupler. Both the HTMM and HTPT disconnect the helitorch from the empty drum. The HTMM disconnects the fuel coupling.
4. Both HTMM and HTPT move the helitorch to the full drum. The HTMM connects the fuel coupling. The HTMM attaches the helitorch to the drum. The HTMM turns on the fuel valve (half open for gelled fuel), turns on the pump and the two ignition switches, and opens inline Mapp and propane gas valve.
5. The HTMM remains at the exchange area to ensure that the cables do not get caught on the helitorch, and the helitorch tip does not contact the ground as the helicopter lifts the helitorch.
6. The HTMM double checks to make sure that the pump and ignition switches are turned on. When the helitorch begins to lift, the HTMM exits toward the parking tender.
7. The HTPT signals the pilot when the helitorch crew is clear.
8. The HTPT signals the pilot to exit into the wind, and observes the helitorch until it is clear of the area.
9. The pilot avoids flying over personnel and equipment.
10. The HTMM and HTPT monitor the helitorch until it is out of the helitorch base area.

Bonding Procedures

Static Electricity Precautions for Batch Mixers and Batch Trucks

1. Check system continuity.
    a. Verify that the hose connecting the suction side of the pump to the tank has continuity.
    b. Verify that the hose connecting the discharge side of the pump to the tank has continuity.
    c. Verify that the hose from the discharge side of the pump to the hose reel has continuity.
    d. Verify that the helitorch fill hose has continuity from the hose reel to the dry-break at the opposite end of the hose.
    e. Verify vapor recovery and removal hose have continuity between the end fittings.
2. Attach vapor removal and recovery hose to camlock fitting. Bond the hose end fitting to the tank prior to connecting hose to camlock fitting. Bonding shall be performed before the camlock cap on the tank is removed.
3. Fuel from bulk fueler. Bond the batch mixer to fuel truck using either electrically conductive hose or a bonding cable.
4. Place powder dispenser on batch mixer tank. The powder dispenser shall be made from electrically conductive material.
5. Bond the powder dispenser to the tank prior to opening the manhole and placing the powder dispenser over the manhole opening.
6. Dispense powder. Use only a metal can or bucket (no plastic) to pour powder into dispenser. Prior to pouring powder into dispenser, bond the metal can or bucket to the batch mixer.

Static Electricity Precautions for Mix Transfer Systems

1. Set up the drums. Bond all drums to each other.
2. Check continuity of hoses.
    a. Verify that the suction hose between the pump and the drum has continuity.
    b. Verify that the helitorch fill and recirculation hose connecting the discharge side of the pump to the drum or the helitorch has continuity.
    c. Verify vapor recovery and removal hose have continuity between the end fittings.
3. Attach vapor removal and recovery hose to camlock fitting.
    a. Bond the vapor hose end fitting to the drum prior to connecting the hose to the camlock fitting.
    b. Bonding shall be performed before the camlock cap on the drum is removed.
4. Fuel from bulk fueler. Bond mix transfer system to fuel truck using either electrically conductive hose or a bonding cable.

5. Place powder dispenser on mix transfer system drum.
    a. Powder dispenser shall be made from electrically conductive material (not plastic).
    b. Bond powder dispenser to the drum prior to removing camlock cap and attaching dispenser to camlock on drum.
6. Dispense powder.
    a. Use only a metal can or bucket (no plastic) to pour powder into dispenser.
    b. Prior to pouring powder into dispenser, bond the metal can or bucket to the drum.

Static Electricity Precautions While Fueling Helitorch with Vapor Recovery Hose Connected to Batch Mixer or Mix Transfer System

1. Check hose continuity. This will have been performed during setup of the batch mixer or mix transfer system.
    a. Verify continuity of the helitorch fill hose.
    b. Verify continuity of vapor hose.
2. Check hose installation sequence during refueling.
    a. Connect helitorch fill hose to fill connection on helitorch drum.
    b. Connect vapor recovery hose to camlock fitting on helitorch drum.

Static Electricity Precautions While Fueling the Helitorch with Vapor Removal Hose Not Connected to Batch Mixer or Mix Transfer System

1. Check hose continuity. This will have been performed during setup of the batch mixer or mix transfer system.
    a. Verify continuity of the helitorch fill hose.
2. Check hose installation sequence during refueling.
    a. Connect helitorch fill hose to fill connection on helitorch drum.
    b. Bond the vapor recovery hose to the helitorch drum prior to removal of the camlock cap or camlock relief valve fitting.
    c. Connect vapor recovery hose to camlock fitting on helitorch drum.

Safety Considerations

Emergency Procedures Ground Response

Establish and follow approved crash rescue plan located in the PASP or MASP.

Chapter 6 – Unmanned Aircraft Systems (UAS) Aerial Ignition

The IAIU will work with Interagency Fire Unmanned Aircraft Systems Subcommittee (IFUASS), OAS, NTDP, Aviation Managers, geographic area coordination groups, and interagency partners/cooperators to develop, coordinate, and implement strategic and tactical UAS operations.

UAS Aerial Ignition qualifications, training, position descriptions and certification requirements for UAS personnel, along with operations standards and approved equipment, are found in *NWCG Standards for Fire Unmanned Aircraft Systems Operations*, PMS 515, https://www.nwcg.gov/publications/515.

Chapter 7 – Device Malfunctions and Emergency Procedures

NOTE: There are many circumstances that can constitute an in-flight emergency. Pilots, aerial ignition supervisors, and PLDOs must understand their roles and responsibilities when responding to an in-flight emergency. The crew must discuss in-flight emergencies and brief to a common understanding of their roles, responsibilities, and procedures. During an emergency is not the time to figure out how to respond to an emergency. This is accomplished through planning, briefings, and training.

Device Malfunctions

This is not an exhaustive list of malfunctions that may occur. For malfunctions not listed in this publication, consult the specific device manual for instructions.

The following are common operational malfunctions that users may experience and their definitions.

- **Clog** – When a sphere does not transfer from the hopper to the feed chute, as seen through the sight glass.
- **Jam** – When a plastic sphere is stuck inside of the device, usually at the slipper blocks.
- **Hangfire** – The progression of a jam that initiates a fire inside of the device.

Premo Malfunctions

1. Operator notifies pilot of problem and gives brief description.
2. Pilot maintains aircraft flight in burn area until emergency is resolved.
3. Operator closes chute feed handles.
4. If device is jammed, operator pulls manual assist wheel outward and rotates it several revolutions forward then backward. If the obstruction clears, check circuit breaker, and notify the pilot and the aerial ignition supervisor before resuming operations.
5. If a fire starts (hangfire), the operator activates the emergency water system for up to 30 seconds. If necessary, the operator may use the additional 1-gallon container of water to extinguish the fire by pouring it down the hopper into the feed chutes. If a problem persists, notify the pilot.
6. Land as soon as practicable.

Reference for Premo Mark III: https://www.sei-ind.com/products/premo-fire-ignition/

Reference for Aerostat Mark V: http://www.aerostatinc.com/index.asp

Red Dragon Malfunctions

The operator is alerted to a jammed sphere by any of the following conditions:

1. “FAULT” indicator on the tethered remote-control flashes.
2. “MOTOR FAULT” indicator on the main control panel illuminates.
3. Manual hand-wheel stops rotation when the feed gates are open and device has power.
4. Flow of spheres into the gate block stops when the feed gates are open and device has power. If a sphere jam occurs in the device, take the following immediate actions:
5. If automatic clearing fails, notify the pilot of the situation.

6. Pilot maintains aircraft flight in burn area until emergency is resolved.
7. Press the manual feed control knob to close and lock the feed gates.
8. Rotate the manual hand-wheel in the reverse and forward directions to clear the jam.
9. If jam clears, notify the pilot that burning can recommence. Toggle the feed gate switch to the "OPEN" position to reopen feed gates.
10. If jam cannot be cleared and sphere ignition occurs:
    a. Toggle the water switch to the "ON" position and hold until the combustion has stopped.
    b. If necessary, pour the additional container of water into the hopper.
    c. Clean the ignition head as detailed in the manual.

Reference for SEI Red Dragon: https://www.sei-ind.com/wp-content/uploads/2021/04/Red-Dragon-Operations-Manual.pdf

Raindance Device Malfunctions

1. Operator notifies pilot of problem and gives brief description.
2. Pilot maintains aircraft flight in burn area until emergency is resolved.
3. Operator presses the stop button on the remote pendant.
4. Operator presses the glycol stop button.
5. Operator repeatedly presses the unload button until the capsules are fully retracted.
6. Cut the damaged incendiary capsules off the capsule belt and place in a bag to stop the potassium permanganate from spilling. Place this bag as far away from the operating device as possible. It may be necessary to use the water pump to clear excessive potassium permanganate.
7. If jam does not clear, or hangfire occurs:
    a. Return master power switch to the off position.
    b. If needed, activate the fire pump until fire is extinguished.
    c. If a problem persists, notify the pilot. Land as soon as practicable.

Reference for Raindance Systems R3: http://www.raindancesystems.com.au/r3/

Emergency Communication and Categories

Aerial ignition operations require clear and concise communication and coordination between the pilot, crew, and ground personnel. Communication is critical for a successful outcome when responding to an aircraft or equipment emergency or malfunction. The pilot is trained to respond to in-flight emergencies in accordance with the rotorcraft flight manual and any supplement thereof, and in compliance with 14 CFRs. The PLDO is trained to respond to equipment malfunctions and emergencies. Because the operation and flight are comprised of both of these elements, it is critically important to conduct a flight brief in order to integrate crew coordination in response to an emergency or equipment malfunction.

There are basically three general classifications of emergencies associated with helicopters. These classifications generally depend on the immediacy required to manage the emergency and the resultant landing criteria.

- **Land immediately** – An immediate landing is required because maintaining flight may not be possible or it may be more hazardous than choosing to land in an inadequate landing site. Land immediately is generally associated with a catastrophic failure or very near-term catastrophic failure.
- **Land as soon as possible** – An emergency allows time to manage the emergency but limits the ability to maintain prolonged flight. A landing without delay should be made at the nearest suitable area where an approach and landing is reasonably assured.
- **Land as soon as practical or practicable** – An emergency allows time to manage the emergency and where flight safety is not critically compromised. However, a landing without delay should be made at the nearest site where a safe approach and landing can be reasonably accomplished.

Flight Brief

The pilot and all associated crewmembers should conduct a thorough flight brief. Incident or project leadership should be notified of any communication and flight protocols to adequately respond to an emergency.

The purpose of the flight brief is to delineate roles and responsibilities, establish clear CRM, develop a common understanding of expectations and flight management responsibilities and protocols, and determine when the variant landing criteria would be exercised. The flight brief should clearly delineate individual crew actions and the communication criteria to initiate action. The prioritized sequential order when responding to an emergency or equipment malfunction are aviate, navigate, communicate.

- **Aviate** – Managing the aircraft is the most critical and number one priority. Fly the aircraft. Appropriately respond to the emergency. Place the aircraft in a less critical environment. Do not move on to navigate or communicate until doing so. Topics to discuss are responses to emergencies that may compromise the ability to control the aircraft. Types of aircraft characteristics that are associated with types of emergencies. Does an external load need to be jettisoned immediately or can it be delayed? Consideration for exiting the low and slow environment (climb to cope). What are common types of emergencies that may require a forced landing? These are but a few topics that need to be addressed during the brief.
- **Navigate** – A discussion of egress options, routes, landing site criteria, and site selection should be conducted so crew understand the difference between land immediately sites, land as soon as possible sites, and land as soon as practicable sites. Egress of the project area and conditions for egressing, such as consideration for jettison of an external load or verification that aerial ignition devices have been properly stopped and secured to prevent ignition outside the burn boundary. Egress routes should be discussed to identify possible en route landing sites. Hazard avoidance should be discussed such as inadvertent instrument meteorological condition (IMC) and, if the burn area cannot be egressed, landing “in the black” and possible brownout (loss of visual reference near the ground due to ground obscurants such as ash and dirt).

- **Communication standards** – In what way or how are emergencies going to be initially communicated to flight crewmembers and ground personnel? Discussion should occur regarding who communicates what to whom and when and how. This is especially critical when an emergency may prevent the pilot from managing cockpit radio switchology or distracting the pilot with the emergency itself. Additionally, identification of key words or phrases should be discussed. Aircraft character indicative of more catastrophic emergencies should be discussed, such as engine loss, power settling, and loss of tail rotor effectiveness as there will likely not be enough time to communicate for some emergencies. The briefing should also include components critical to crew survival after landing and there should be an awareness made to the incident or project leadership.
- **Crew response** – The purpose of these discussions is to establish a set of procedures so that they are unnecessary to be addressed directly, while in flight, especially if the emergency prevents the ability to communicate effectively or there is little time to respond to the emergency. Topics to be discussed should include considerations for jettison and management of equipment and the operation. It should include survivability considerations, management of burn operations, and management of common aircraft and equipment malfunctions. This discussion should include pre- and post-crash survival topics such as secondary restraint connections, securing or jettisoning equipment, repositioning seating, survival equipment (what and where equipment is located on the respective aircraft), egressing the aircraft, manually engaging the Emergency Locator Transmitter (ELT), purpose and usefulness of the onboard fire extinguisher.

Immediate Response to Land Immediately or As Soon As Possible Emergencies

Immediate response addresses an emergency where the criteria determine whether the aircraft will land immediately or as soon as possible. There are several emergencies that fall into this category and landing criteria largely depends on the magnitude of the failure and how significantly flight safety is compromised. During this type of emergency survival is often a function of establishing an adequate profile to successfully land the aircraft and will include the immediate jettison of any external load.

The objective of the flight brief is to establish key words, phrases, or conditions that initiate an immediate response by crewmembers. The words and phrases should be briefed inclusive of the immediate action items.

Although key phrases or words have been identified for use, clear and concise direct communication is likely going to be required to adequately address any emergency, regardless of conformity to these key words or phrases. It is understood and appropriate to deviate as necessary to address emergencies as each emergency is very different depending on the indications of the emergency, the flight environment, and the phase of operations.

Examples of land immediately or land as soon as possible emergencies

- Engine failure or impending failure
- Main rotor or tail rotor failure or impending failure
- Loss of aircraft control due to a hydraulic failure or mechanical component failure
- Transmission, gearbox, or driveshaft failure or impending failure
- Chip light
- Significant loss of power due to a fuel metering system failure or engine component failure
- Excessive aircraft vibrations
- Engine or aircraft fire
- Loss of tail rotor effectiveness
- Power setting or settling with power
- Dynamic rollover due to snagging of the external load

Delayed Response to Land As Soon As Practicable Emergencies

A delayed response addresses an emergency where the assessment of the emergency or system malfunction continues to provide the ability to remain in flight without compromise to aircraft control. There are a number of emergencies that fall into this category, largely depending on the magnitude of the failure and the potential impact of the ability to extend the flight of the aircraft to a landing site that provides assurance that a safe approach and landing can be made.

These emergencies are generally characterized by a system failure indication or impending failure indication where management of the emergency results in the ability to safely remain aloft for a longer duration than that of an immediate landing or land as soon as possible emergency.

During this type of emergency, it is critical to exercise good judgment and awareness with regard to accurately diagnosing the emergency so as not to compound the emergency to a more severe degree. It is important to manage altitude and airspeed to remove the aircraft from a more hazardous flight environment, and to communicate effectively with crew and external agencies what the emergency is, what needs to be done, and what to prepare for.

For delayed response emergencies, plain language is the best form of communication. However, it remains critical to thoroughly brief conduct of actions because the brief establishes a set of common protocols and procedures. It lays the foundation of a plan.

Although key phrases or words have been identified for use, clear concise direct communication is likely required to adequately address this type of emergency. It is understood and appropriate to deviate as necessary to address emergencies as each emergency is very different depending on the indications of the emergency, the flight environment, and the phase of operations.

Examples of land as soon as practicable emergencies

- Indications of a system malfunction or fault
- Oil temperature and oil pressure light
- Hydraulic temperature or pressure light
- Unknown master caution
- Unusual vibrations or limited control authority
- Electrical malfunction
- Lost communication either internal (ICS) or external (radio)
- Adverse environmental conditions
- Line entanglement
- Inadvertent IMC
- Aircraft or ignition device equipment malfunction

PSD Emergency Response Actions

The following is to brief all crew prior to flight.

NOTE: While flight profiles for aerial ignition operations often do not allow enough time to perform all the duties below, it is still important to have the discussion as an aircrew of emergencies and the actions for each role. "Mayday, mayday" and the subsequent actions taken by the pilot and crew will occur almost simultaneously. Increasing the altitude and speed of the helicopter will provide you more time if an emergency occurs. Limiting low altitude and slow flight profiles is critical to mitigate the risk associated with aerial ignition operations.

PSD Immediate Response Actions
PILOT DUTIES
• **Aviate**. Manage the emergency. • **Navigate**. Manage the flight profile. Remove the aircraft from the low and slow environment. Begin to egress the burn area. • **Communicate** the emergency. "Mayday, mayday" to alert aircrew and ground resources. Notification should be made on the incident or project frequency. • Activate ELT and prepare for impact.
AERIAL IGITION SUPERVISOR DUTIES
• Ensure ELT has been activated. • Cease aerial ignition operations. • Advise project personnel of the emergency, current location, route of flight, altitude, heading, and intended area. • Assume crash position and prepare for impact.

PLDO DUTIES
Time permitting: • Close feed gates. • Disconnect hopper electrical plug from main frame. • If crash immanent, jettison the hopper from the helicopter in a safe location (no resources below the helicopter), if possible, and communicate to the pilot that it has been jettisoned. • Secure aft cabin. • Position body inside the aircraft and assume a modified crash position with feet on or above the PSD main frame. Prepare for impact.
AFTER LANDING

• Protect and preserve life.
• Ensure main rotor blades have stopped prior to exiting the helicopter.
• If conditions allow:
  ○ Turn off helicopter fuel.
  ○ Turn off helicopter battery.
  ○ Turn on ELT.
  ○ Located and use ALSE equipment if practicable.
• Stay calm and provide care to all injured personnel and wait for assistance.
• If possible, communicate your status and current location.
• If landing within the burn area, be aware of encroaching fire, and determine if movement away from the helicopter is required.

PSD Delayed Response Actions
PILOT DUTIES
• **Aviate**. Manage the emergency. • **Navigate**. Manage the flight profile. Remove the aircraft from the low and slow environment. Begin to egress the burn area. • **Communicate** the emergency. Alert aircrew and ground resources. Notification should be made on the incident or project frequency. • As the situation progresses, the pilot shall advise aircrew and ground personnel of any emergency updates, egress route, or landing site.
AERIAL IGNITION SUPERVISOR DUTIES
• Cease PSD operations. • Communicate the emergency and the response plan to dispatch and ground resources via the FM frequency. • Secure the cabin of loose articles and prepare for a forced landing. • Advise dispatch and ground personnel of location, altitude, route and heading, intended landing site, and any emergency updates.

PLDO DUTIES
• Close feed gates. • Communicate when spheres have ceased dropping, “Chute is clear.” • Turn of PSD device and state, “Device is secure.” • Position body inside the aircraft and assist with communication and coordination as needed.
AFTER LANDING

• Protect and preserve life.
• Ensure main rotor blades have stopped prior to exiting the helicopter.
• If conditions allow:
  ○ Turn off helicopter fuel,
  ○ Turn off helicopter battery,
  ○ Turn on ELT,
  ○ Locate and use ALSE equipment if practicable.
• Stay calm and provide care for all injured personnel and wait for assistance.
• If possible, communicate your status and current location.
• If landing within the burn area, be aware of encroaching fire, and determine if movement away from the helicopter is required.

Torch Emergency Response Actions

The following is to brief all applicable participants prior to flight.

Torch Immediate Response Actions
PILOT DUTIES
• **Aviate**. Manage the emergency.   ○ Jettison, as required (avoid jettison over personnel or outside the burn area). • **Navigate**. Manage the flight profile. Remove the aircraft from the low and slow environment. Begin to egress the burn area. • **Communicate** the emergency. “Mayday, mayday” to alert ground resources. • Activate ELT and prepare for impact.
AFTER LANDING

• Protect and preserve life.
• Ensure main rotor blades have stopped prior to exiting the helicopter.
• If conditions allow:
  ○ Turn off helicopter fuel,
  ○ Turn off helicopter battery,
  ○ Turn on ELT,
  ○ Locate and use ALSE equipment if practicable.
• Stay calm and provide care for all injured personnel and wait for assistance.
• If possible, communicate your status and current location.
• If you are located within the burn area, be aware of encroaching fire, and determine if movement away from the helicopter is required.

Torch Delayed Response Actions
PILOT DUTIES
• **Aviate**. Manage the emergency.   o Jettison, as required (avoid jettison over personnel or outside the burn area). • **Navigate**. Manage the flight profile. Remove the aircraft from the low and slow environment. Begin to egress the burn area. • **Communicate** the emergency. Alert aircrew and ground resources. Notification should be made over the incident or project frequency. • As the situation progresses, the pilot shall advise ground personnel of route, a change to intended landing site, or any update of the emergency.
AFTER LANDING

• Protect and preserve life.
• Ensure main rotor blades have stopped prior to exiting the helicopter.
• If conditions allow:
  o Turn off helicopter fuel,
  o Turn off helicopter battery,
  o Turn on ELT,
  o Locate and use ALSE equipment if practicable.
• Stay calm and provide care for all injured personnel and wait for assistance.
• If possible, communicate your status and current location.
• If you are located within the burn area, be aware of encroaching fire, and determine if movement away from the helicopter is required.

Aerial Ignition Incident Reporting

The personnel associated with the operations are responsible for reporting aerial ignition incidents through the proper aviation channels at the unit, forest, and regional levels and will use a SAFECOM to report these incidents. (www.safecom.com)

Chapter 8 – Reference Materials

Safety Data Sheets (SDS)

DISCLAIMER: Due to the three-year cycle for this document, users should consult the manufacturer's website for the current versions of specific SDS sheets.

The use of trade, firm, or corporation names listed above and contained in specific SDS sheets is for information and convenience of the reader and does not constitute an endorsement by the IAIU of any product or service to the exclusion of others that may be suitable.

- MAPP Gas — Methylacetylene Propadiene Propane: https://worthingtonindustries.com/getmedia/ff77868e-b526-44ae-9064-e51aaa5ea02f/wc001-map-pro-premium-hand-torch-fuel
- Liquefied Petroleum Gas or Propane: https://worthingtonindustries.com/getmedia/126702bb-c40c-48f5-8131-0ee2712f3380/wc002-propane
- Gasoline, Unleaded: http://www.marcnelsonoil.com/assets/no-e-gasoline-unleaded-regular.pdf
- Jet A-1 — Turbine Fuel, Aviation: https://www.cpchem.com/sites/default/files/2020-05/01541670_6.pdf
- Jet Fuel Jp-4 — Turbine Fuel, Aviation: https://www.cpchem.com/sites/default/files/2020-05/01543807_6.pdf
- Ls No. 2 Diesel Fuel — Diesel Fuel: https://chamberlainoil.com/wp-content/uploads/2011/08/Shell%20Diesel%202%20New.pdf
- Aldrich Chemical Sub of Sigma-Aldrich — 22346-8 Potassium Permanganate 99%: https://msdsreport.com/ds.cfm?msds=bvsyl&name=22346-8%20potassium%20permanganate%2099%25%20a%20c%20s%20reagent&mfg=aldrich%20chemical%20co%20sub%20of%20sigma%20aldrich
- Firetrol® Petrol JelTM Liquid Fuel Gelling Agent: https://www.fs.fed.us/eng/aerial_ign/fuelgel/gelagent/petrogel/documents/msds.pdf
- Firetrol® Firegel (also known as Sure Fire), Chemonics Industries, Inc.: https://www.fs.fed.us/eng/aerial_ign/fuelgel/gelagent/firegel/msds.htm
- Inhibited Ethylene-Glycol Antifreeze: https://www.cleartech.ca/ckfinder/userfiles/files/Ethylene%20Glycol,%20Inhibited%20CTI%20SDS.pdf
- PHOS-CHeK Flash 21 A: https://385xpfxe1e13almu7u8sj31b-wpengine.netdna-ssl.com/wp-content/uploads/2015/04/FLASH-21A-2014.pdf
- PHOS-CHeK Flash 21 B: https://385xpfxe1e13almu7u8sj31b-wpengine.netdna-ssl.com/wp-content/uploads/2015/04/Flash-21-B-2012.pdf.pdf
- Halliburton MO-85M & MO-86M: https://msds.halliburton.com/msdsdocuments.aspx?doc_url=https://msds.corp.halliburton.com/wercs/DirectDocumentDownloader/Document?prd=HM005396~~PDF~~MTR~~US~~EN https://msds.halliburton.com/msdsdocuments.aspx?doc_url=https://msds.corp.halliburton.com/wercs/DirectDocumentDownloader/Document?prd=HM005397~~PDF~~MTR~~US~~EN

- All employees shall receive information regarding hazardous substances and materials to which they may be exposed to, and receive appropriate SDS.
    - SDS – designed to help us understand how to work safely with hazardous material (chemicals) that are used during the helitorch operation.
    - SDS explains proper ways to use, handle, and store chemicals, identifies health hazards, provides precautionary measures to follow, and outlines emergency procedures for spills, fire, and first aid.

Aerial Ignition Equipment Modifications

Reference Appendix D (https://www.nwcg.gov/publications/501).

- BLM Instruction Memorandum on Aerial and Ground Ignition Equipment Direction
- USFS memo on Required Safety Modifications: Batch Mixer, Terratorch, Mix Transfer System, and Helitorch
- Northern (Canadian) Barrel Helitorch Required Safety Modifications
- Premo Mark III Modifications
- Aerostat Mark V PSD Approval Letter
- Helicopter Operations Harness, Tether & Tether Attachment Drawing. MTDC-993
- Western Helicraft Helitorch modification

The *NWCG Standards for Aerial Ignitions (NSAI)* is developed and maintained by the Interagency Aerial Ignition Unit (IAIU), under the direction of the National Interagency Aviation Committee (NIAC), an entity of the National Wildfire Coordinating Group (NWCG).

Previous editions: 2021, 2018, 2015, 2012.

While they may still contain current or useful information, previous editions are obsolete. The user of this information is responsible for confirming that they have the most up-to-date version. NWCG is the sole source for the publication.

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