N9016
Plastic Sphere Dispenser Operator

Instructor Guide

Certified: September - 2025

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Revision History

Version	Description	Date
1.0	Course Revision Completed & Certified	09/2025

Certification Statement
on behalf of
Interagency Aerial Ignition Unit

The following training material meets the criteria outlined in the *NWCG Standards for Aerial Ignition PMS 501* to support the aviation training requirements of the USDA Forest Service and U.S. Department of the Interior (DOI) customers. Each state agency possesses the authority to require implementation of this training to meet the training requirements.

The instruction is for interagency use and is known as:

N9016 Plastic Sphere Dispenser Operator

N9016—Plastic Sphere Dispenser Operator

Course Delivery
The Instructor Guide outlines a program of instruction aimed at providing each student with a standardized block of training. While experience and teaching skills may vary between instructors, the Instructor Guide provides guidelines and standard content for each instructor to use in delivering the course. This ensures that each student receives the same content, regardless of the instructor or organization conducting the class.

Course Objectives
Instructors are encouraged to enhance course materials to reflect the conditions, resources and policies of the local unit and area if the objectives of the course and each unit are not compromised.

Exercises
Exercises can be modified to reflect local practices, resources, and conditions; however, the objectives and purpose of the exercises must remain intact. Additional exercises may be added to certified course materials at the instructor's discretion.

Testing/Student Evaluation

Test questions may be added that reflect any local information that may have been added to the course. However, test questions in the certified course materials are not to be deleted to ensure the accurate testing of course and unit objectives.

Test grades, to determine successful completion of the course, shall be based only on the questions in the certified course materials.

Course Hours

The hours listed may vary slightly due to factors such as number of students, types, and complexity of course activities, and the addition of local materials.

The Interagency Aerial Ignition Unit (IAIU) will make every effort to update relevant changes in the practice and policy of the course by updating the course as applicable.

Inaccuracies and/or recommendations for improvement should be submitted using the NWCG Course Feedback form. Feedback submitted will be evaluated and, as appropriate, incorporated into the appropriate courses.

N9016—Plastic Sphere Dispenser Operator

Course Overview

Course Purpose

The purpose of this course is to provide participants with the knowledge and skills to safely operate as a Plastic Sphere Dispenser Operator (PLDO). At the conclusion, of this course, participants should be able to demonstrate the knowledge and skills necessary to safely operate the PSD device they are trained on, understand agency policy as it relates to aerial ignition operations, identify aircraft performance and limitations and risk management measures to implement to reduce PSD mission risk and exposure.

Target Audience

Interagency personnel who utilize a Plastic Sphere Dispenser device for aerial ignition missions.

Course Prerequisites

Specific required training and qualifications can be found in the current Federal Wildland Qualifications Supplement to the NWCG PMS 310-1.

Prior to enrollment in PLDO training, students must complete the following pre-requisites:

Pre-Requisites:

- An Introduction to the National Incident Management System (IS-700)
- Introduction to the Incident Command System (ICS-100)
- Wildland Fire Safety Training Annual Refresher (RT-130)
- Aviation Transportation of Hazardous Material (A-110); triennial requirement

Delivery Method

There are two approved delivery methods for this course.

1. Instructor-led, classroom delivery to include a hands-on demonstration of the skills identified in the position taskbook for PLDO.
2. Online delivery of N9016 course content, followed by instructor-led hands-on demonstration of the skills identified in the position task book for PLDO.

Cadre Requirements

Minimum one (1) qualified N9016 instructor. It is recommended that two (2) qualified N9016 instructors be present for the entire class and hands-on field session.

Instructor Qualification
Minimum instructor qualifications for the course will vary based on agency specific requirements.

Plastic Sphere Dispenser Operator (PLDO) lead instructor must be qualified and current as a PLDO on the specific aerial ignition device to be taught, and a Helicopter Manger (HMGB), or previously qualified as or less currency as HMGB.

Initial Certification:

Required Experience: Qualified Helicopter Crewmember
Test Requirements: 70% for passing
Task Book: Completion of task book
Model Specific: Additional model specific training is required on any device not covered in initial training.
Cross Training: Device cross training will be documented on the *Aerial Ignition Device Additional Training* form found in PMS 501. This training may be completed in a classroom or in the field on a wildland or prescribed fire operation. A flight with the device to finalize additional device training is at the discretion of the instructor based on the PLDO's knowledge and experience with PSD operations**.**
Currency: To remain current and qualified as a PLDO, personnel will need to attend an annual RT9016 session AND serve in the PLDO position at minimum once every three years. Forest Service requires PLDO personnel to maintain currency as Helicopter Crewmember (HECM).

Recommended Class Size
Class size—instructor preference (minimum = 2; maximum = 20)
The number of students in a class is based on a variety of factors—e.g., number of PSD devices available for the hands-on field portion of the course, classroom accommodations, etc.

Course Length
Approximately 4 – 6 hours.

Course Materials

Required Instructor Materials:
(This is what the instructor needs to have on hand to teach)

Supplies:
- N9016 Instructor Guide
- N9016 PowerPoint Presentation

Equipment:
- Laptop computer, projector & screen, extension cords & power strip
- Speakers
- Internet access – recommended
- PSD device and took kit
- PPE for bench testing the device
- Bench testing equipment as identified in the PMS501

Required Student Materials:
- NWCG Standards for Aerial Ignition PMS 501 (hard copy or electronic) and required PSD forms for each student
- PLDO position task book for each student
- PSD device manual (hard copy or electronic) for each student

	Unit 0—Welcome and Course Introduction
#1	**Course Title: N9016 — Course Title** Instructor(s) welcome students to the course and introduce themselves.
#2	**Course Logistics** **Instructor Note:** This slide in the Power Point is meant to be customized by each instructor with information that is specific to their timeline and instructional facilities. The instructor provides students the landmarks within the training facility and highlights policies applicable to the training: • Facilities: restrooms, vending machines, water fountains • Course schedule: breaks, lunch, etc. • Cell phone policy • Evacuations plan, including emergency exits, muster location, fire alarm, etc. • Student references • Field exercise
#3	**Introductions** **Instructor Note:** This slide in the Power Point is meant to be customized by each instructor based off the students in the class. Have participants give a quick introduction of themselves; this may include the following: • Your name • Where do you work? – Agency and unit • Your position • How long have you been involved in helicopter operations
#4	**N9016 Plastic Sphere Dispenser Operator** This slide provides an overview of the course, and the topics covered in each unit. **Instructor Note:** Unit 8 is the hands-on field session; instructors should communicate PPE requirements and expectations for the field session to students.

	Unit 1— The History of PSD and Current Devices
#5	**Unit 1 History of PSD and Current Devices** **Unit Introduction** This unit will cover the history and progression of PSD devices and the devices that are utilized in operations today. **Unit 1 Objectives** • Understand the history of the Plastic Sphere Dispenser (PSD) • Identify the approved PSD devices as stated in the *NWCG Standards for Aerial Ignition PMS 501* • Review the advantages and disadvantages of PSD in relation to helitorch operations

#6	**The History of PSD**
	PSD devices were developed to provide a method of igniting ground fuels, in a short time, on large acreage, without causing undue damage to the over story. This method was required to be cost effective, environmentally acceptable, and readily available.
	Aerial ignition devices which were first utilized with fixed wing aircraft, have been modified over the years to work on helicopter and unmanned aerial systems (UAS).
	• **Pharmaceutical vials**
	  ○ (1972) Pharmaceutical vials containing potassium permanganate were hand injected with glycol via syringe. Which caused an exothermic reaction, like today's spheres. The vials were then dropped from the aircraft. Their irregular size made it difficult to put them in devices for more efficient use.
	• **Delayed Action Incendiary Device (DAIDs)**
	  ○ 7" long device equipped with a 30 second safety fuse. Both ends of each DAID were coated with a modified match head compound, then a layer of high melting point wax to prevent accidental ignition when rubbing together in transit. A helicopter crash in Australia in 1978 discontinued the use of DAIDS
	• **Development of dispensers**
	  ○ The Canadian Forest Service developed a more modern-day dispenser.

	Unit 1— The History of PSD and Current Devices
#7	**The History of PSD** • Alberta Department of lands took the vials developed in Australia and altered them to be consistent sized spheres made of polystyrene. The new spheres also contained a consistent amount of potassium permanganate. In 1977 the Alberta Department of Lands worked with the Pacific Forest Research Center (PFRC) to develop the Mark II.
#8	**Approved PSD Devices** **Instructor Note:** Refer students to the PMS 501, Chapter 3 – Approved Aerial Ignition Devices. Review the approved devices, agency manufactured or modified devices and aerial ignition device approval process in this chapter. • Premo Mark III • SEI Red Dragon • PSDS Mark V ○ **Should be removed from service by 2027** • Raindance • UAS – Ignis Regardless of the device utilized, the basic function of all PSD devices are the same; The device injects undiluted ethylene glycol into a plastic sphere or capsule that contains a specific amount of potassium permanganate. The sphere or capsule is then ejected from the device, and after a time delay an exothermic reaction occurs, igniting the sphere. **Instructor Note:** The Raindance device utilizes capsules instead of spheres and does not utilize glycol. Additional information is covered on this device in slide 11.

#9	**Premo Mark III and Red Dragon**
	The Premo Mark III and the Red Dragon are the most utilized devices for PSD operations in the US.
	• **Premo Mark III**
	  ○ Premo Mark III was developed in the early 1980s and approved for use in 1986
	• **SEI Red Dragon**
	  ○ The SEI Red Dragon was developed in the early 2000s and was approved for use in 2009.

	Unit 1— The History of PSD and Current Devices

#10	**Aerostat Mark V and Raindance R3 Aerial Incendiary Device**
	• **Aerostat Mark V**
	  ○ The Aerostat Mark V is very similar to the Premo Mark III; the Mark V utilizes the same design concept and spheres as the Premo, but it weighs slightly less (93 lbs.).
	  ○ **New purchases of this device are NOT authorized; all Aerostat Mark V devices should be removed from service by 2027.**
	• **Raindance R3 Aerial Incendiary Device (AID)**
	  ○ The R3 utilizes PSD capsules as opposed to spheres; the capsules are attached together in a string and are fed into the device. It can drop anywhere from 6 to 240 capsules per minute.
	  ○ The device does not utilize ethylene glycol (antifreeze) like other devices, it instead utilizes the developing companies own “Purple Incendiary Catalyst” to create the reaction and ignite the capsule.
	  ○ The device is more commonly utilized in Australia.

#11	**UAS Ignis**
	• 30 minutes of flight time
	• Range varies with topography and fuel type. 1-2 nautical miles easy answer
	• The PSD device has the following features:
	  • Uses standard Dragon Egg ignition spheres and full-strength antifreeze.
	  • Current maximin load of 450 spheres, drop rate of up to 120 spheres per minute.
	  • Future system will see 1,000 sphere – 4,000 sphere hoppers and increased flight times.

#12	**PSD vs. Helitorch – Advantages** It is important to recognize that both PSD and helitorch have their advantages and disadvantages when it comes to aerial ignition operations. Some the advantages of PSD over helitorch include: **Complexity:** • PSD operations can be configured and completed anywhere (i.e. Helibase, helispot, etc.) whereas helitorch operations require a larger area to support all the equipment and personnel. Helitorch operations also requires its operating area away from other aircraft and personnel to ensure the safety of all personnel and equipment involved. • The quantity and volatility of hazmat utilized for PSD operations is substantially less than that of helitorch operations. **Improved Control:** • Aerial Ignitions Supervisor (AIS) and PLDO can assist the pilot with identifying and staying within unit boundaries, as well as provide feedback to the pilot on sphere spacing. The AIS can also communicate with ground personnel in the event a sphere is observed crossing the unit boundaries. • The PLDO can troubleshoot the device. Whereas if there is an issue with the helitorch the pilot will need to return to the Helibase. • Throughout the flight the PLDO can monitor the quantity of spheres remaining. The pilot does not have an accurate way to gauge the amount of gel remaining in the helitorch. **Fire Behavior:** PSD spheres will fall through the canopy (majority of the time), limiting damage to the canopy. All involved in PSD missions should recognize that as spheres drop; they may bounce and/or roll off ridges, rocks, etc. With the helitorch operations the gel will not readily drop through the canopy and will likely ignite the canopy. **Lower Cost:** PSD operations require less equipment and personnel to execute. Thereby making the initial startup and execution cost lower than helitorch operations. The PSD device also only utilizes spheres and glycol which are substantially cheaper compared to the use of fuel and mixing agent for helitorch.
#13	**PSD vs. Helitorch Disadvantages**

	Unit 1— The History of PSD and Current Devices
	Some the disadvantages of PSD over helitorch include: **Fire Behavior** • Spheres burn for a short amount of time • Ignition lines can take longer to develop • Cannot replicate Helitorch Intensity **Risk Management** • Requires additional personnel on board • The PLDO could experience device malfunctions that may lead to a hang fire in the device (hang fires will be discussed later in the course). If the PLDO is unable to extinguish the hang fire they may need to jettison the device from the aircraft. If required to do so there is a specific series of steps and communication protocol to follow. The steps required, size and weight of the device may make it difficult to jettison from the helicopter quickly. (Steps for jettisoning the device will be covered later in the course) • In the event of an emergency, it is essential for the safety of the PLDO that their outboard leg is brought inside the helicopter, the device is secured, separation from the device maintained, and a crash position established in the event of a hard or crash landing. Additional information on emergency procedures will be covered in Unit 7.

	Unit 2—PSD Training Qualifications & Responsibilities
#14	**Unit 2 Objectives** • Identify PLDO training and qualifications requirements • Discuss aircraft and pilot carding procedures for PSD operations • Compare the differences in the PSD organization for prescribed fire and wildland fire • Define PLDO position responsibilities
#15	**PLDO Training requirements** • **PLDO Prerequisite Required Training:** o An Introduction to the National Incident Management System (IS-700) o Introduction to the Incident Command System (ICS-100) o Wildland Fire Safety Training Annual Refresher (RT-130) o Aviation Transport of Hazardous Material (A-110 – Triennially). • Satisfactory performance as Helicopter Crewmember (HECM) & • Complete and certification PTB as Plastic Sphere Dispenser Operator (PLDO) • Test requirements: 70% for passing • Position Task Book: Completion of task book • Model Specific: Additional model specific training is required on any device not covered in initial training. <u>Qualified PLDO instructors can only teach to the devices they are qualified for.</u> • **RT9016 annually following completion of N9016** • **Cross Training:** Device cross training will be documented on the *Aerial Ignition Device Additional Training* form found in PMS 501. This training may be completed in a classroom or in the field on a wildland or prescribed fire operation. A flight with the device to finalize additional device training is at the discretion of the instructor based on the PLDO's knowledge and experience with PSD operations. • **Currency:** To remain current and qualified as a PLDO, personnel must attend an annual RT9016 session AND serve in the PLDO position at minimum once every

	three years. Forest Service requires PLDO personnel to maintain currency as Helicopter Crewmember (HECM).

	Unit 2—PSD Training Qualifications & Responsibilities
#16	**Pilot Training and Qualification Requirements** To become qualified for aerial ignition the pilot must be qualified for basic helicopter fire operations including recon and surveillance, helitack passenger transport and bucket operations. Each pilot must also complete the IAT *A-110 Aviation Transportation of Hazardous Materials* training online tri-annually. The pilot will then attend an initial PSD training (this training) and then may be give a verbal and/or flight maneuvers evaluation by a Helicopter Inspector Pilot (HIP).
#17	**Aircraft Carding Requirements** The aircraft will be inspected by an Aircraft Maintenance Inspector (AMI). All helicopters that will be used for PSD operations shall be equipped with a power source for the PSD device. Reference the wiring diagram in the aircraft contract and the PMS 501 for additional information. PSD devices may be secured in the helicopter utilizing a belly strap or approved model specific hard points.

	Unit 2—PSD Training Qualifications & Responsibilities
#18	**Aerial Ignitions Organization – Prescribed Fire** • All required forms are in Appendix A of the PMS 501. Instructors should show students where to locate the required forms online for PSD operations and have copies of each form available for them to reference throughout the course. https://www.nwcg.gov/publications/pms501 *If utilizing a PSD scenario for the course, have students complete either a prescribed or wildland fire org. chart. • Aerial ignition operations must be overseen by a qualified supervisor – for prescribed fire operations, only a Firing Boss (FIRB), a Type 1 or Type 2 Burn Boss • (RXB1 / RXB2) may direct aerial ignition operations. • Depending on the complexity of the aerial ignition operations, users may elect to add additional helibase or helispot management or support positions, this may include: HEBM, ABRO or others deemed necessary for the operation. • A helibase manager is required anytime there are two or more helicopters operating out of the same location and/or assigned beyond one day. • Personnel working under NWCG positions shall follow the *Standards for Helicopter Operations* (NSHO) and specific agency fire and aviation qualification standards.

	Unit 2—PSD Training Qualifications & Responsibilities
#19	**Aerial Ignitions (WF)** • For a wildfire PSD operation, a Firing Boss, Operations Section Chief (OSC), Division/Group Supervisor (DIVS), Type 1 or Type 2 Burn Boss (RXB1 / RXB2) may direct aerial ignition operations. • Depending on the complexity of the aerial ignition operations, users may elect to had additional helibase or helispot management or support positions to include: HEBM, ABRO or others deemed necessary for the operation. • A helibase manager is required anytime there are two or more helicopters operating out of the same location and/or assigned beyond one day. • Personnel working under NWCG positions shall follow the *Standards for Helicopter Operations* (NSHO) and specific agency fire and aviation qualification standards.
#20	**PLO Responsibilities** Serves as PLDO for the aerial ignition supervisor. PLDO may have collateral duties as the HMGB. • 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
#21	**Helicopter Manager (HMGB) Responsibilities** • Position Responsibilities– Duties and responsibilities are outlined in NSHO. HMGB may have collateral duties as the PLDO or FIRB.

	Unit 2—PSD Training Qualifications & Responsibilities
#22	**Pilot Responsibilities** • **The pilot will follow the ignition plan under the direction of the aerial ignition supervisor.** Unless there are flight constraints. Which should be discussed in the pre-flight briefing. • **The pilot-in-Command is responsible for all matters related to** - aircraft operations and safety - weight and balance - performance planning - PSD installation oversight - helicopter load calculation Good communication and Crew Resource Management (CRM) is critical in making this operation work safely and effectively.
	Unit End

	Unit 3— Device Function and Maintenance (Premo Mark III)
	Unit Title— Device Function and Maintenance **Instructor Note:** Use this unit(s) to the device you are qualified to teach. There are portions of the unit that are identical. If you are teaching both devices, you will need to adjust your slides. Consider having the actual device during this unit.
#1	**Unit 3 Objectives** After completing Unit 3, students should be able to: ❖ Identify the parts and basic functions of the device ❖ Demonstrate knowledge necessary to o Operate o Troubleshoot o Perform routine maintenance o Clean the PSD device **Instructor Note:** Give the students an electronic or hard copy of the device manuals to refer to throughout this unit.
#2	**Glycol** o Standard Vehicle Antifreeze (90-100% Ethylene Glycol) o Do Not use 50/50 Pre-Mixed Antifreeze o Do not use non-toxic Propylene Glycol Antifreeze **Always refer to the device manufacturer's recommendation for glycol usage. While most devices will utilize ethylene glycol, this should be confirmed in the manufacture's manual prior to use.** When glycol interacts with potassium permanganate it initiates an exothermic reaction that leads to ignition of the sphere. Utilization of glycols other than standard ethylene glycol may inhibit the reaction. Which can cause no or poor ignition results.

	Unit 3— Device Function and Maintenance (Premo Mark III)
#3	**PSD Spheres** • **Ignition lag time is recommended not to be less than 20 seconds** *If ignition times are less than 20 sec. try calibrating the level of glycol (the Red Dragon does not allow the PLDO to adjust the level of glycol), keep spheres and glycol in the shade/out of direct sunlight and in a cool area until they will be used. If necessary, mix the glycol to a 50/50 mix with bottled water to delay ignition lag times.* • **Do not use carry spheres onboard in containers that cannot be secured inside the helicopter.** • Potassium permanganate should not be inhaled, absorbed or come in contact with the skin or eyes. **Utilize PPE when inspecting spheres, bench testing and cleaning devices. Clean up residue and spills promptly.** **Instructor Note:** (Refer to the Safety Data Sheets (SDS) for Potassium Permanganate and Ethylene Glycol) • **Sphere boxes have critical information on them including when and where they were manufactured**. **Save all boxes until ignitions are complete; if there are sphere issues the information on the box should be included in SAFECOM report and be reported to the manufacturing company so troubleshooting may occur**. A shelf life for PSD spheres has not been identified. However, it has been identified that spheres need to be kept dry, that extreme temperature variations, and exposure to ultraviolet light should be avoided. Boxes should also be rotated/agitated at minimum annually to prevent the potassium permanganate from clumping on the inside of the sphere (clumped potassium permanganate may affect ignition results). Unused spheres should be stored in a clean plastic bag and the original box. **Storage of PSD Spheres and Glycol should be separated from each other to avoid inadvertent interaction.** **Instructor Note:** (Refer to the Safety Data Sheets (SDS) for Potassium Permanganate and Ethylene Glycol)

	Unit 3— Device Function and Maintenance (Premo Mark III)
#4	**PSD Accessories** There are a variety of PSD device accessories available. ○ Sphere bags range from 1,000-4,000 capacity (Make sure lanyards and attachments are functional and secured) ○ Tool kits for specific device **<u>The PLDO will not disassemble ANY PSD device components during flight</u>. Tool kits may be carried on board the aircraft to fix or troubleshoot device issues. The helicopter must land prior to disassembling or working on any device component.** ○ Bench Testers and Power Sources **Absolutely no batteries will be carried in the cabin to power the PSD device during firing operations. The device must be powered through the aircraft's electrical system.**
#5	**Premo Mark III System Overview** The video goes over the components and their functions of the Premo Mark III device. **Instructor Note:** The following 8 slides go over each component and function as well. Adapt instruction to facilitate the needs of the student(s).
#6	**Premo Mark III Function** • Spheres are loaded into the hopper at the top of the device • An agitator load balls into four chutes located on the front of the device • Slipper blocks move the spheres into the needle/plunger system where they are injected with glycol • The cam shaft slides the slipper block back to release the injected sphere down the exit chute and out of the aircraft to the ground. Control panel switches operate the main drive motor, glycol pump, device speed and the emergency water supply. The hopper contains a separate control panel to turn the agitator on and off. Power to the device is through a 3-pin quick disconnect.

	Unit 3— Device Function and Maintenance (Premo Mark III)
#7	**Overall Components** - Total weight with spheres, glycol (2.4 gallons) and water tank (1 gallon) filled– 98 pounds. Device weights and additional specifications can be found in the manufacture manual. **Instructor Note:** If able, review the company website with the students to also make them aware of the "Bulletins" section which contains equipment and technical information bulletins.
#8	**Hopper and Feed Chutes** - The hopper will hold up to 450 spheres and there are four feed chutes with a clear plexiglass site view. Prior to connecting the hopper power cable to the mainframe of the device ensure the hopper is toggled to "off" and the device is off. Connecting the hopper cable with the power on in either location could lead to a power arch which could damage the device. The hopper has its own control panel separate from the control panel on the mainframe of the device. Turning the hopper "on" will enable the agitator to move.
#9	**Hopper and Feed Chutes cont.** - The hopper and feed chutes are not securely connected. It is important that when the hopper is being positioned on or off the main frame of the device that these two pieces remain snug; and are not allowed to separate from each other. As seen in the bottom left picture, highlighted by the yellow circle. Separation of the two pieces could lead to a jam in the device. Some hoppers may have the hopper position lock which prevents the hopper from separating from the chute when the hopper is placed on or removed from the mainframe of the device.
#10	**Feed Controls and Levers** - 45-130 spheres dispensed a minute depending upon settings - slow or fast speed and two chutes or four chutes. **Best Practice:** When able, operator's right hand remain on the feed control levers, when in the closed position. This is to prevent inadvertent opening.

	Unit 3— Device Function and Maintenance (Premo Mark III)
#11	**Feed Control Levers cont. –** To open two chutes, squeeze the middle “unlock” lever on the center chute control lever and then lift the chute control lever up. To open four chutes, squeeze the middle “unlock” lever on the outer chute control lever and then lift the chute control lever up. Control levers must be completely horizontal to close feed chutes; when closing the control levers do not force or put undo pressure on the control levers to prevent damaging the feed chutes or levers.
#12	**Control Panel and Manual Assist** – The control panel switches are series wired so that the drive motor can be operated independently of the glycol pump. However, the glycol pump will not operate unless the drive motor is turned on. The emergency water switch is also found on the main control panel. To operate the emergency water, push and hold the button. • **Initial start-up sequence**: Toggle the hopper switch to “on,” turn the drive motor to on and select “fast” or “slow”, turn the glycol pump on, and then open the desired number of feed control levers (2 or 4). • **Shut down sequence:** Close the feed control levers (ensure they are in a completely horizontal position), visually verify that the device is no longer dispensing spheres and then turn off the glycol pump, drive motor and hopper (if securing the device to leave the unit to ensure spheres are not accidently dispensed outside of the boundaries). **Instructor Note:** Unit 7 will cover additional information on start-up/shutdown and device malfunction responses.

	Unit 3— Device Function and Maintenance (Premo Mark III)
#13	**Components** – The glycol tank which is housed in the device's mainframe holds 2.4 gallons of glycol. The emergency water tank holds 1 gallon of water when filled and sits on top of the device's main frame and underneath the hopper. **The emergency water will not work without power to the device.** Whenever possible, utilize bottled water to fill the emergency water tank to prevent build up and sediment in the tank and lines. Which could lead to clogged water lines or emergency water ports. To connect the water hose, remove the cap of the glycol tank. Then loosen the wing nuts on both sides of the device to remove the lid. This gives you access to the water pump and other inner workings. The water hose from the pump to the emergency water tank can get kinked. **Tip:** Place the hose over the top of the glycol tank and gently bend upwards. The cams move the slipper blocks forward, pushing the sphere against the needle/plunger assembly and injecting the sphere with glycol. The blocks then move backward to dispense the sphere down the exit chute and to the ground.
#14	**Premo Mark III Cleaning and Maintenance** Refer to the manufacture's manual for additional troubleshooting and cleaning information. **Prior to cleaning and maintaining the device ensure you have an adequate work area, supplies and PPE. PPE (eye protection, long sleeves and nitrile gloves) should be worn during the cleaning process; do not allow others without proper PPE into the cleaning area.**
#15	**Premo Mark III Cleaning and Maintenance** This is a video going over basic cleaning and maintenance.

	Unit 3— Device Function and Maintenance (Premo Mark III)
#16	**Premo Mark III Cleaning and Maintenance** DO NOT delay cleaning the device, potassium permanganate is corrosive and will harden; it should not be allowed to sit on the device to ensure continued optimal performance. The device should be cleaned with water, CRC 656 or 666 and degreaser or equivalent. When potassium permanganate is mixed with water it becomes a dark purple liquid that may stain metals, cloth and personnel's skin. Once dried, lubricate all moving parts with "Tri-flow" or "Never Seize". **WD-40 IS NOT recommended** as it is known to accumulate potassium permanganate dust and cause the slipper blocks to seize. Ensure the device is dry before storing.
#17	**Premo Mark III Cleaning and Maintenance** **INSTRUCTOR NOTE:** The photo on the right shows an extreme case of how dirty things may be. Inform students that this is not normal. If the device and/or aircraft is this dirty, the spheres should be inspected. A SAFECOM being filed should be considered. • Remove the device from the helicopter for cleaning. Work with the pilot/mechanic on cleaning up potassium permanganate inside and outside the aircraft. Inspect the outside of the aircraft to ensure it is clean of any potassium permanganate residue, tape or other materials from protecting the door sill, and paint from the device/chute. • Empty the water tank; the device should be stored with the glycol tank full and the water tank empty. If the device will be in extended storage empty the glycol tank, pump and valve block. • Empty the hopper and feed chutes of all spheres. • Wipe down the outside and inside of the hopper • Remove the feed chutes and clean out any loose potassium permanganate. • Visually inspect all parts to ensure no damage has occurred inspect the hinges and hopper lid, ensure the agitator plate is clean and operational, ensure all screws and components are in place and tight. When possible, rinse out or soak the inside of the exit chute to remove glycol and potassium permanganate residue.

	Unit 3— Device Function and Maintenance (Premo Mark III)
#18	**Premo Mark III Cleaning and Maintenance** When potassium permanganate encounters water it will turn a purple color. • Spray down the slipper block assembly and needles with water and wipe. A brush may be helpful to remove some of the clumped or hardened potassium permanganate. • Spray water into the slipper blocks and work the manual assist back and forth while continuing to spray. • Remove the cam plate from the top of the cams and thoroughly clean underneath. Allow cam area to dry prior to reinstalling the cam plate. An air compressor or canned air can be useful to remove clean potassium permanganate out of small nooks and crannies on the device as well as expedite drying. All PPE and extreme caution must be utilized if using a compressor or canned air to clean the device.
	Unit End

	Unit 3— Device Function and Maintenance (Red Dragon)
	Unit Title— Device Function and Maintenance **Instructor Note:** Use this unit(s) to the device you are qualified to teach. There are portions of the unit that are identical. If you are teaching both devices, you will need to adjust your slides. Consider having the actual device during this unit.
#1	**Unit 3 Objectives** After completing Unit 3, students should be able to: ❖ Identify the parts and basic functions of the device ❖ Demonstrate knowledge necessary to o Operate o Troubleshoot o Perform routine maintenance o Clean the PSD device **Instructor Note:** Give the students an electronic or hard copy of the device manuals to refer to throughout this unit.
#2	**Glycol** o Standard Vehicle Antifreeze (90-100% Ethylene Glycol) o Do Not use 50/50 Pre-Mixed Antifreeze o Do not use non-toxic Propylene Glycol Antifreeze **Always refer to the device manufacturer's recommendation for glycol usage. While most devices will utilize ethylene glycol, this should be confirmed in the manufacture's manual prior to use.** When glycol interacts with potassium permanganate it initiates an exothermic reaction that leads to ignition of the sphere. Utilization of glycols other than standard ethylene glycol may inhibit the reaction. Which can cause no or poor ignition results.

	Unit 3— Device Function and Maintenance (Red Dragon)
#3	**PSD Spheres** • **Ignition lag time is recommended not to be less than 20 seconds** *If ignition times are less than 20 sec. try calibrating the level of glycol (the Red Dragon does not allow the PLDO to adjust the level of glycol), keep spheres and glycol in the shade/out of direct sunlight and in a cool area until they will be used. If necessary, mix the glycol to a 50/50 mix with bottled water to delay ignition lag times.* • **Do not use carry spheres onboard in containers that cannot be secured inside the helicopter.** • Potassium permanganate should not be inhaled, absorbed or come in contact with the skin or eyes. **Utilize PPE when inspecting spheres, bench testing and cleaning devices. Clean up residue and spills promptly.** **Instructor Note:** (Refer to the Safety Data Sheets (SDS) for Potassium Permanganate and Ethylene Glycol) • **Sphere boxes have critical information on them including when and where they were manufactured**. **Save all boxes until ignitions are complete; if there are sphere issues the information on the box should be included in SAFECOM report and be reported to the manufacturing company so troubleshooting may occur**. A shelf life for PSD spheres has not been identified. However, it has been identified that spheres need to be kept dry, that extreme temperature variations, and exposure to ultraviolet light should be avoided. Boxes should also be rotated/agitated at minimum annually to prevent the potassium permanganate from clumping on the inside of the sphere (clumped potassium permanganate may affect ignition results). Unused spheres should be stored in a clean plastic bag and the original box. **Storage of PSD Spheres and Glycol should be separated from each other to avoid inadvertent interaction.** **Instructor Note:** (Refer to the Safety Data Sheets (SDS) for Potassium Permanganate and Ethylene Glycol)

	Unit 3— Device Function and Maintenance (Red Dragon)
#4	**PSD Accessories** There are a variety of PSD device accessories available. ○ Sphere bags range from 1,000-4,000 capacity (Make sure lanyards and attachments are functional and secured) ○ Tool kits for specific device **<u>The PLDO will not disassemble ANY PSD device components during flight</u>. Tool kits may be carried on board the aircraft to fix or troubleshoot device issues. The helicopter must land prior to disassembling or working on any device component.** ○ Bench Testers and Power Sources **Absolutely no batteries will be carried in the cabin to power the PSD device during firing operations. The device must be powered through the aircraft's electrical system.**
#5	**Premo Mark III System Overview** The video goes over the components and their functions of the Premo Mark III device. **Instructor Note:** The following 11 slides go over each component and function as well. Adapt instruction to facilitate the needs of the student(s).
#6	**Red Dragon Function** • Spheres are loaded into the hopper at the top of the device • An agitator load balls into two chutes located on the front of the device • Injection shuttle guides the spheres into the needle/plunger system where they are injected with a set amount of glycol • The cam moves the injection shuttle back to release the injected sphere down the exit chute and out of the aircraft to the ground. The hopper is powered by the device when connected to the mainframe. Power to the device is through a 3-pin quick disconnect. The device also has a removable base to fit various helicopter configurations (not shown in this picture).

	Unit 3— Device Function and Maintenance (Red Dragon)
#7	**Red Dragon Function & Maintenance** **Total weight with spheres, glycol (0.8 gal), water (0.5 gal) tanks filled – 70 pounds** **Hopper capacity 650 spheres** -The Red Dragon utilizes smaller spheres than other aerial ignition devices. The device's mounting base may not be needed depending upon the type of aircraft it will be utilized in (i.e. Astar does not require the use of the mounting base with the flat cabin floor). Seven drop rates from 25 – 175 spheres per minute **Instructor Note:** If able, review the company website with the students to also make them aware of the "Bulletins" section which contains equipment and technical information bulletins. Also point out the device's remote control, power cord, and y-strap.
#8	**Red Dragon Components - Hopper** The hopper on the Red Dragon can hold up to 650 spheres that are dispensed through two chutes. Power is provided to the hopper through a multi-pin connector that automatically connects when the hopper is placed onto the mainframe of the device. The hopper is then locked into place on the mainframe via the locking handle. The agitator within the hopper feeds dragon eggs down the chutes that supply spheres to the feed gates. Secondary stops, located at the outlet of the chutes automatically close and prohibit spheres from exiting the hopper when it is removed from the mainframe.
#9	**Red Dragon Components - Chute** Both thumbnuts must be located on the outside of the injection head and chute. Placing either of these nuts on the inside of the chute will cause the spheres to get hung up inside the chute (first generation models of devices), or if the thumbnuts are not installed in the correct order there is potential to lose a nut during operations.

	Unit 3— Device Function and Maintenance (Red Dragon)
#10	**Red Dragon Components - Main Frame** • Tank Assembly- There are a few different versions of glycol and water tank caps and will vary depending upon how old the device is. • The short pigtail power cord on the device is connected to a longer 15' power cable that is then connected to the aircraft. A bench test power cord is also provided. One end of the bench test power cord will connect to the device while the other end is fitted with ¼" ring terminals for attachment to a battery for bench testing. • **The water tank contains a sensor inside that tank that if there is an insufficient level of water in the tank it will not allow the drive motor to operate until additional water is added**. **The emergency water is normally powered by the external power supply (aircraft), however if there is a loss of external power there is a backup battery that will supply power to the emergency water pump**. (The battery is located inside the mainframe under the control panel, it's location will be shown in an upcoming slide) • Both the glycol and water tank can be drained on the bottom of the device. Simply insert a length of hose into the drain valves and then open the valves with a flat head screwdriver on the side. • In the event of a device malfunction, he manual knob allows the PLDO to manually close the feed gates. When the device is set to "RUN" and the feed gate switch toggled to open, the manual knob will be pushed outwards and flush with the side of the device. Pushing the manual knob in will cause the feed gates to close. (More information on the feed gate assembly and manual knob can be found in upcoming slides.)

	Unit 3— Device Function and Maintenance (Red Dragon)
#11	**Red Dragon Components - Controls** To open two chutes, squeeze the middle “unlock” lever on the center chute control lever and then lift the chute control lever up. To open four chutes, squeeze the middle “unlock” lever on the outer chute control lever and then lift the chute control lever up. Control levers must be completely horizontal to close feed chutes; when closing the control levers do not force or put undo pressure on the control levers to prevent damaging the feed chutes or levers.
#12	**Red Dragon Components – Feed Gate Assembly** Spheres exit the hopper into the sphere paths; in each sphere path, a feed gate that is attached to the control rod. When the feed gate switch is toggled to “open.” • The open solenoid activates and pulls out the locking pin. • This causes the feed control rod to move outwards into the fully open position and open the feed gates. • This allows spheres to enter the injection head, where they are injected with glycol and dispensed from the device. When the feed gate switch is toggled to “close.” • The close solenoid activates and brings the control rod inwards. • This engages the feed gates, and spheres can no longer pass. This can also be done manually by the PLDO by pushing the manual knob in. If the feed gates do not open or close, check the power connections on the open solenoids; they may come loose or disconnected.

	Unit 3— Device Function and Maintenance (Red Dragon)
#13	**Red Dragon Components - Injection Head** As spheres exit the feed gate assembly, they fall into one of two cavities in the injection shuttle. The shuttle moves side to side, which causes the sphere to contact the injection needle and be punctured. As the shuttle moves further, the sphere presses against the pump arm, causing glycol to be injected into the sphere. The shuttle then reverses direction, extracting the sphere from the injection needle. It then passes through the center position, and the primed sphere drops from the injection shuttle into the exit chute. The two shuttle cavities are arranged so that when one side injects a sphere, the other drops a sphere down the exit chute. The constant displacement glycol pumps deliver the same quantity of glycol to every sphere regardless of the drop rate utilized. This system eliminates the need for the PLDO to calibrate the glycol system. To prime, the pump assemblies may be removed from the injection head, then squeeze the pump arm repeatedly until glycol flows from the injection needle. Each pump assembly is secured to the injection head by two captive screws. The Red Dragon has an automatic jam detection and clearing system. If the device detects a jam, the PLDO is notified by a “FAULT” indicator light on the remote control and control panel. The manual hand wheel will briefly stop rotating, then reverse direction to clear the jammed sphere from the system, then resume rotating the normal direction. The jam detection and clearing system operation should be tested before operations. An easy way to test this function is to take a rubber-coated tool handle, turn the device onto speed 1, open the gates, and hold the tool handle on one side of the injection shuttle.

	Unit 3— Device Function and Maintenance (Red Dragon)
#14	**Red Dragon Components - Injection Head** The Red Dragon contains an automatic system to detect and clear sphere jams in the shuttle. However, should the automatic system fail to clear a jam or the unit loses electrical power, the handwheel can turn the drive motor and cam in either direction to clear a jammed or broken sphere. **Note the "CAUTION" sticker on the top near the sphere paths**. If the hopper is placed on the device while spheres are in the sphere path, the device will automatically jam when it is turned on. **Instructor Note:** Unit 7 will cover additional information on start-up/shutdown and device malfunction responses.
#15	**Red Dragon Components - Interior** The drain valves for glycol/water have "quick" disconnects that release the hose. To remove them, push up on blue portion and pull out the hose. There is a water filter between the water tank and the water hoses. It is important that this filter is visually inspected prior to use. If it is dirty and/or clogged, remove and flush it clean or replace it. Some water lines may contain updated water check valves to prevent the emergency water system from continuously leaking after use. If the emergency water system leaks and the updated check valves are not installed, new valves should be installed. If new valves are not available, a bit of compressed air should be blown from the emergency water port back into the system to "reseat" the check valve. Glycol filters are located on each glycol line. They should also be inspected and cleaned/replaced as necessary. SEI also offers a new drive motor that will look slightly different from what is shown on the PowerPoint. Always inspect the wiring harness to the drive motor. Open and close solenoids to ensure all connections are tight and will not loosen or fall off in flight. This could disrupt the device's power or the ability of the feed gates to open or close.

	Unit 3— Device Function and Maintenance (Red Dragon)
#16	**Red Dragon Components – Interior Electrical** There is a picture of the circuit board mounted beneath the main control panel, which is the “brains” of the Red Dragon. It contains the microprocessor and all additional components. If newer components/parts are added (i.e., an updated drive motor), the circuit board firmware may need to be updated to operate correctly with the new component. **The internal battery will power emergency water even if the device’s power is disrupted. Always test the emergency water without power to ensure the battery is operable.** **This battery charges every time the device is plugged in. If the main control display flashes “batt,” the device may need to be plugged in for a while to recharge fully. If it continues to flash “batt,” you may need to replace your internal battery completely.**

	Unit 3— Device Function and Maintenance (Red Dragon)
#17	**Red Dragon Cleaning & Maintenance** **INSTRUCTOR NOTE:** If the device and/or aircraft is excessively dirty, the spheres should be inspected. A SAFECOM being filed should be considered. DO NOT delay cleaning the device. Potassium permanganate is corrosive and will harden; it should not be allowed to sit on the device to ensure continued optimal performance. • Remove the device from the helicopter for cleaning. Work with the pilot/mechanic on cleaning up potassium permanganate inside and outside the aircraft. Inspect the outside of the aircraft to ensure it is clean of any potassium permanganate residue, tape or other materials from protecting the door sill, and paint from the device/chute. • The device should be cleaned with water and/or simple green. (See manufacture's recommendation for approved cleaning materials) • **DO NOT lubricate the device**. The injection shell, drive cam, and injection block have an aluminum/polyacetal interface that is self-lubricating. The use of products such as Tri-Flo, WD-40, or a light machine oil will cause dirt and potassium permanganate to accumulate. Which may lead to mechanical seizures. • Drain both the glycol and water tanks; inspect the glycol and water filters. Filters that show residue, such as this water filter, should be flushed clean or replaced. • Inspect all wiring harness connectors and ensure all are still tightly connected.
#18	**Red Dragon Cleaning & Maintenance** This is a video going over basic cleaning and maintenance. **Instructor Note:** Use the video in conjunction with the next slides according to the student's needs.

	Unit 3— Device Function and Maintenance (Red Dragon)
#19	**Red Dragon Cleaning & Maintenance** • Wipe down all components to remove any residual potassium permanganate. • Inspect all components for sign of wear including the hopper, agitator, and linkages • Inspect the plexiglass to ensure it is still adequately attached to the hopper lid. Left picture shows hopper plexiglass is separating from the frame. • Check the tightness of all screws on the hopper. If needed, add Loctite to secure screws. Bottom picture shows screws on the outside of the hopper's chute area beginning to back out. This could lead to the device jamming. • When possible, rinse out or soak the inside of the exit chute to remove glycol and potassium permanganate residue.
#20	**Red Dragon Cleaning & Maintenance** • Ensure that the holes in the injection needles face up, as shown in this picture. This will reduce the amount of glycol dripping onto the device during operations and keep the device cleaner throughout. Inspect the needles to ensure they have not become clogged with potassium permanganate. • Keep needles sharp to prevent the device from jamming. If you experience numerous jams, inspect the sharpness and length of the needles. If the needles are too short, it will cause the device to jam. The picture in the bottom right corner shows the correct length of needles. • Inspect the tightness of all screws. Especially those that will prevent the movement of the slipper blocks and lead to jams and/or the device seizing. Yellow circle highlights screw to pay particular attention to.

	Unit 3— Device Function and Maintenance (Red Dragon)
#21	**Red Dragon Cleaning & Maintenance** The injection head can be removed by loosening the two captive screws. This will allow access to thoroughly clean and inspect the needle/pump system and the shuttle area. • Remove glycol pump assemblies from injection head • Check pump operation • Clean the injection shuttle and injection block The needles may also need to be removed to clean the pump arm adequately.
	Unit End

	Unit 4—PSD Safety and Safety Considerations
#1	**Unit 4 Objectives** • Discuss the hazards and risks of a PSD flight profile and safety measures that may be implemented to reduce risk • Identify required Personal Protective Equipment (PPE) and safety equipment for PSD operations • Describe how to properly handle hazardous materials and reference the Emergency Response Guidebook (ERG)
#2	**PSD Safety and Safety Considerations** Aerial ignition provides a clear benefit to land managers. However, it is not without risk. The aerial ignition mission poses risks to those executing it, ground personnel, and the public. • Due to the nature of the mission, aviation personnel may have limited options in the event of an aircraft emergency or malfunction. • Ground personnel and the public are also at risk due to the fire's ability to quickly spread across the landscape. Should a fire behave erratically or escape containment, it could have devastating consequences. It is imperative that all involved in aerial ignition operations, and others involved at all levels, have identified hazards and the associated risks, have implemented mitigations, and have weighed the risk vs. the benefit for each operation. This unit will discuss safety equipment, and PPE required for PSD missions. This unit will review aircraft performance considerations and limitations. Units 5, 6, and 7 will provide additional information on device and inflight procedures, wildfire environmental factors, device malfunctions, and emergency procedures.

	Unit 4—PSD Safety and Safety Considerations
#3	**Safety – Personal Protective Equipment** • Flight helmet • Nomex clothing, natural fiber under garments • Flight or leather gloves • Fire approved boots • Cold weather gear **Instructor Note:** Refer to the Interagency Aviation Life Support Equipment Guide.
#4	**Safety - Equipment** • Approved Secondary Restraint Secondary restraints are covered in the next slide. • A fire shelter for each occupant in the helicopter cabin. All fire shelters are required to be secured and accessible within the aircraft cabin. Fire shelters will be in areas that would not reduce the crash extenuation of any aircraft component (i.e., under the seats) or restrict passengers' egress. All personnel should be briefed on the location of the fire shelters. • 1 gallon of water An additional 1 gallon of water must be secured on board. This is if the device's emergency water system is insufficient to extinguish a fire. The PLDO should always check that the gallon of water is within reach, easily accessible, and is able to be poured down the hopper if needed. • J-knife / seatbelt cutter The PLDO must have access to a J-shaped safety knife (seatbelt cutter) suitable for rapid cutting of the tether. If desired, the PLDO may also secure a knife or seatbelt cutter to the device for jettison purposes. **Instructor Note:** If possible, have students practice removing their safety knife and cutting some old webbing from their seated position. Consider doing it while the webbing is taut and with slack.

	Unit 4—PSD Safety and Safety Considerations
#5	**Secondary Restraints** **The primary restraint is the seat belt, which must be worn at all times**. The secondary restraint may consist of either an approved full body harness or gunners strap (reference IALSE for approved secondary restraints). The PLDO shall wear an approved restraint, tether, and carabiner. The secondary restraint system must also be attached to an approved hard point in the aircraft. **The secondary restraint must be adjusted to prevent the PLDO from extending past the plane of the door sill of the aircraft.** **Before use, inspection must be completed on the harness/gunner strap, tether, tether attachment, and carabineer must be inspected daily**. When inspecting equipment, visually inspect: • Stitching and webbing for abrasion, wear, tears, or other damage. • Check all buckles, rings, and adjusters for damage. Ensure all are functioning as intended. • Inspect carabineers for cracks, deformations, corrosion, wear, or other damage. Ensure that gates/sleeves close, lock and open properly. • If in doubt on any piece of equipment, REMOVE from service immediately! The harness/gunner strap, tether, and tether attachment shall have a date stamp. **All equipment will have a maximum life cycle of 10 years after the date of manufacture. Equipment more than 10 years old or not meeting manufacture inspections standards must be replaced.**

	Unit 4—PSD Safety and Safety Considerations
#6	**Secondary Restraint Installation** The video goes over installation of the secondary restraint in several models of aircraft. The next slide has pictures. **Instructor Note:** Use the video with the next slide according to the student's needs. • **All secondary restraint systems must be attached to rings or brackets approved through a supplemental type certificate (STC) or aircraft seatbelt rings.** • **Once installed, the PLDO and pilot should visually inspect the restraint system to ensure that remains clear of all flight controls and switches during aerial ignitions.** • **Before operations, it is highly recommended that all PLDOs practice a crash position.** The PLDO needs to get their outboard leg in quickly, identify a way to protect themselves from the device and demonstrate the proper crash position. • **PLDOs should also practice egressing their secondary restraint by primary and secondary means.** The PLDO should practice manipulating the primary and secondary restraint releases. **In an emergency, the crash position and egress should be muscle memory.**

	Unit 4—PSD Safety and Safety Considerations
#7	**Secondary Restraint Installation** • **All secondary restraint systems must be attached to rings or brackets approved through a supplemental type certificate (STC) or aircraft seatbelt rings.** • **Once installed, the PLDO and pilot should visually inspect the restraint system to ensure that remains clear of all flight controls and switches during aerial ignitions.** • **Before operations, it is highly recommended that all PLDOs practice a crash position.** The PLDO needs to get their outboard leg in quickly, identify a way to protect themselves from the device and demonstrate the proper crash position. • **PLDOs should also practice egressing their secondary restraint by primary and secondary means.** The PLDO should practice manipulating the primary and secondary restraint releases. • **In an emergency, the crash position and egress should be muscle memory.**

	Unit 4—PSD Safety and Safety Considerations
#8	**Safety – Hazardous Materials** Required documents may be electronic or printed documents. The PIC is directly responsible and is the final authority for the safe operation of the aircraft to include the acceptance of hazardous materials. • **DOT 9198 Special Permit Authorization** • **NWCG Standards for Aviation Transport of Hazardous Materials (PMS 513)** • **Hazardous Materials Manifest Form** A Notification of Pilot-In-Command (NOPIC) of Hazardous Materials must occur using the Hazardous Materials Manifest Form (Appendix 1 of PMS 513). This should be completed during the aircraft pre-use inspection and provided to the pilot before the first flight of the day. After that, load calculations and manifest documentation are acceptable. **INSTRUCTOR NOTE:** Ensure students have seen copies of the Special Permit DOT-SP 9198 and the *Hazardous Material Manifest.* If not, take a few minutes to explain how the permit works in conjunction with the *Hazardous Material Manifest* and where they can find both documents. • **Emergency Response Guidebook (ERG)** The Emergency Response Guidebook (ERG) is updated every four years. Ensure the most recent copy is available in the helicopter. **INSTRUCTOR NOTE:** If students are unfamiliar with the ERG information and organizational layout, review it with them.

	Unit 4—PSD Safety and Safety Considerations
#9	**Safety - Hazardous Materials** **INSTRUCTOR NOTE:** For additional information on handling hazardous materials, students should reference SDS and the *NWCG Standards for Aviation Transport of Hazardous Materials PMS* 513. • **The potassium permanganate within the PSD spheres/dragon eggs is hazardous material and must be handled and transported appropriately. All spheres must always be kept separate from glycol to prevent accidental ignition. During transport, glycol and spheres must be in separate compartments.** • **The glycol tank must be filled and refilled at least 25' from the aircraft. Extra glycol is not to be carried on board the helicopter.** • **Spheres must also be kept separate from batteries and battery fluids/acid. The PSD device must be able to be powered by the aircraft's electrical system; under no circumstance will batteries be carried on board to power the PSD device.** **All flammable aerial ignition components (hopper, sphere bags, etc.) must be able to be jettisoned in an emergency.** All carpet and porous floor coverings must be removed from the aircraft.

	Unit 4—PSD Safety and Safety Considerations
#10	**Risk Management** Although helicopters are quite reliable, emergencies can and do occur. Accidents during PSD operations have occurred and resulted in severe injuries and multiple fatalities. Policy requires that risk shall be mitigated to As Low As Reasonably Practical (ALARP). Risk management must be fully integrated into the mission's planning, preparation, and execution of the mission by all personnel. A pilot's ability to recover control of a malfunctioning helicopter during a typical PSD mission has a low probability of success because of the low altitude and speeds often utilized to accomplish PSD missions. Managing risk associated with PSD operations requires a conscious and constant evaluation of hazards, risks, and mitigation measures. Utilizing the MASP/PASP as a briefing tool, completing the Go No-Go Checklist, through performance planning, completing an operational risk management tool such as a GAR or DORA, and developing CRM will assist personnel in the risk management process. **Instructor Note:** Consider having an MASP/PASP, the Go No-Go Checklist, and an Operational Risk Management Tool for students to look over.

#11	**Risk Management – Flight Profile**

INSTRUCTOR NOTE: Consider reviewing a SAFECOM, Lessons Learned, Safety Alert, etc., that discusses a flight profile incident during PSD operations, i.e., loss of tail rotor effectiveness (LTE).

By knowing the conditions that could potentially lead to an emergency, many potential accidents can be avoided. Helicopter emergencies and recovery procedures should be discussed.

Consider increasing the weight reduction beyond that of policy and/or contractual standards to ensure adequate power is available. Increasing the margin could reduce the susceptibility to power settling and loss of tail rotor effectiveness.

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/or "Hovering Out of Ground Effect" (HOGE) profile. Pilots must consider "escape routes" and maintain the ability to avoid additional risk potential during low/slow/HOGE flight profiles**.

All involved should use CRM to exit/avoid "low and slow" when exposure is unnecessary. The crew remains empowered to manage and/or decline the remainder of the flight or the mission.

Loss of Tail Rotor Effectiveness (LTE) – a critical, low-speed aerodynamic flight characteristic that can result in an un-commanded rapid yaw rate that does not subside of its own accord. If not corrected, can result in the loss of aircraft control. LTE is not a mechanical failure of the tail rotor system.

Factors that increase the likelihood of encountering LTE include:

- Low airspeed
- High density altitude
- Poor performance planning
- Certain wind conditions when operating at low airspeeds
- High gross weight
- Low rotor RPM
- Poor pilot technique

Vortex ring state, formerly known as settling-with-power - an aerodynamic condition in which a helicopter may be in a vertical descent with 20 percent up to maximum power applied, and little or no climb performance

	Unit 4—PSD Safety and Safety Considerations
	If an event occurs, the mission should be immediately aborted, the aircraft returned to base and the event reported to local and regional aviation managers. The event should also be documented in a SAFECOM for accident prevention, and lessons learned purposes. **Instructor Note:** If a pilot is in the class, ask them to clarify and answer questions on these emergency situations.
#12	**Risk Management – Flight Profile** **A "prescription of flight characteristics" should be discussed and understood by the pilot, aerial ignitions supervisor, and PLDO to reduce the probability of an aviation accident and increase the likelihood of pilot and passenger survivability in an accident.** **Factors to discuss and consider include:** - Height Velocity Curve -Experience level of the pilot, AIS, and PLDO - Fuels and terrain - Hazards - Weather - % of canopy cover throughout the unit = % of emergency landing areas - Values at risk -Resources available = Ground-based tools to complete precise burning - Rx prescription – fire effects, tree mortality, etc. **When reviewing and discussing the Height-Velocity Diagram, it is important to recognize that this performance section has been predicted for to occur when an engine failure occurs over a level, hard surface that is free of obstacles. This diagram does not provide information for the forested, uneven, soft surfaces or otherwise unprepared landing areas in which we operate.** **CRM is essential to ensure that flight profiles subject to loss of tail rotor, power settling, and height velocity concerns are avoided and/or exited when it is not necessary to be exposed** (i.e., when in the middle of a unit where sphere accuracy is not vital to the operation, increase both altitude and airspeed)

	Unit 4—PSD Safety and Safety Considerations
#13	**Helicopter-Delivered Plastic Sphere Dispenser Accuracy Evaluation** In February of 2021, the USFS, in conjunction with the Southeast Region FWS and USFS National Technology and Development Program (NTDP), conducted the *Helicopter-Delivered Plastic Sphere Dispenser Accuracy Evaluation - Premo Mark III and the SEI Red Dragon*. In this evaluation, both the Premo Mark III and Red Dragon were tested for drop accuracy at varying heights to determine if higher altitudes may be flown during PSD missions to increase the safety of operations. **The Premo Mk III PSD generally maintained a high degree of accuracy at altitudes up to 600 feet AGL.** The SEI Red Dragon device appeared to have a lower degree of accuracy, with difficulty even at an altitude of 300 feet AGL. However, it is not believed that the SEI Red Dragon is less accurate. That the increased gusty and variable winds experienced during testing affected the SEI Red Dragon evaluation. Compared to the conditions encountered while evaluating the Premo Mark III. **To reduce flight times spent in the shaded portion of the height-velocity curve, crews should practice flying PSD missions at higher altitudes (Above Ground Level). Especially in lower risk areas where precise placement of spheres is not required**.
	Unit End

	Unit 5—Flight Preparation (Premo Mark III) and Inflight Procedures
#1	**Unit Objectives** • Demonstrate knowledge of the operational functions before, during, and after the mission • Demonstrate knowledge of the firing commands and actions of a PLDO

	Unit 5—Flight Preparation (Premo Mark III) and Inflight Procedures

#2	**Personnel Preparation**
	• **Attend briefing**
	If the PLDO cannot attend the operations briefing the aerial ignitions supervisor may provide the briefing to the PLDO.
	• **Aircraft safety briefing**
	As part of the aircraft safety briefing, the aerial ignitions supervisor should receive a detailed briefing on the aircraft radio and mixer panel operations. All personnel should also discuss sterile cockpit procedures and work to develop positive (CRM) prior to and throughout the flight.
	• **Recon flight**
	If space allows on the recon flight, prior to ignitions, the PLDO should be a part of the recon flight. During the recon flight personnel will:
	  • Review the unit boundaries
	  • Discuss hazards and flight profiles
	  • Identify emergency landing locations near the burn unit
	• **Pre-Mission briefing**
	Before the first flight, all aerial ignition and helicopter personnel at the helibase or helispot will complete a briefing. Items discussed during the pre-mission briefing include:
	  • Responsibilities and assignments
	  • Crash rescue and emergency response
	  • Communications – tracking and/or flight following
	  • Aircraft reconfiguration for bucket work
	  • Communications – frequencies, flight following procedures and identifiers
	  • Environmental concerns such as weather and fire behavior
	  • Review manifests, load calculations, weight and balance, emergency procedures and PSD commands
	  • Review of the Mission Aviation Safety Plan (MASP) / Project Aviation Safety Plan (PASP) and completion of the Go No-Go Checklist and risk assessments.

	Unit 5—Flight Preparation (Premo Mark III) and Inflight Procedures
#3	**Aircraft Preparation** Work with pilot and mechanic on prep of the aircraft. • Remove all loose items – may include seat cushions • Remove rear door • Install tether/harness • Protect the aircraft door sill and paint • Handheld radio on board (Best Practice) • Fire shelters inside the aircraft, for all on board.
#4	**Bench Testing – Premo Mark III** • **Ensure all personnel involved are wearing the proper PPE** • Clear area of flammables and non-essential personnel • Fill the device with glycol and water • Connect the power cord to the proper power supply. • Place a metal container under chute; do not add water. Water in the metal container may cause the sphere to not to ignite or delay reaction time. *If two devices are available, consider bench testing both devices. **Instructor Note:** Have device manual available to reference. Consider having the device out for some hands-on bench testing.
#5	**Bench Test – Premo Mark III and Red Dragon** This slide has video with prep for bench testing and bench testing, for both devices. **Instructor Note:** If teaching to one device reference the slide notes for time stamps.

	Unit 5—Flight Preparation (Premo Mark III) and Inflight Procedures
#6	**Bench Test – Premo Mark III** • **Prime the pumps** • **Drop several EMPTY spheres into desired feed chutes.** If empty spheres are available begin the bench test with the empty spheres to visually confirm the amount of glycol being injected into the spheres. Spheres should be approximately 1/8th full. • **If empty spheres meet the recommendation of the amount of coolant repeat the process with spheres containing potassium permanganate.** • **Lift the feed control handles.** • **Pull out the manual assist and rotate until one sphere drops into the slipper block.** Calibration may be required for proper ignition times Temperature and humidity may affect ignition delay. This could cause delays to be greater than 20 seconds. Adjust the injector control valves by loosening the lock nuts and rotating the valve screw to get desired ignition times **Instructor Note:** Refer to the device manual. If device manual differ from best practices, point out the subtle differences.
#7	**Installation – Premo Mark III** Work with pilot and mechanic when installing device. Each aircraft has subtle differences that the pilot and mechanic can help address. **Instructor Note:** Either explain the installation process to students referencing this slide or proceed to the next slide and play the installation videos
#8	**Installation – Premo Mark III – ASTAR** Video goes over the device installation in the ASTAR.
#9	**Installation – Premo Mark III – Bell Medium** Video goes over the device installation in the Bell Medium.

	Unit 5—Flight Preparation (Premo Mark III) and Inflight Procedures
#10	**Installation – Premo Mark III – Bell 206/407** Video goes over the device installation in the Bell 206/407.
#11	**Flight Preparation** Personnel onboard the helicopter shall be limited to essential personnel. Additional occupants may include instructor or trainees if essential to the mission. • Ensure all equipment is installed properly • Helicopter's electrical system has been tested • Additional gallon of water secured in the aircraft within reach of PLDO • Review sphere spacing/ Device settings (i.e., 4 on Red Dragon = Mark III) • Conduct a review of commands and actions with aerial ignitions supervisor, PLDO, and pilot • Ensure bucket is operational and ready for reconfiguration Best Practice: If there is only one aircraft available for burn, prep bucket for potential suppression needs.

	Unit 5—Flight Preparation (Premo Mark III) and Inflight Procedures
#12	**Premo Mark III Firing Commands and Response** **INSTRUCTOR NOTE:** Prior to class search for PSD SAFECOMs filed related to PSD commands/responses. To relay the importance of all parties Aerial Ignitions Supervisor, PLDO and the pilot, understanding the commands and response required.Past SAFECOMs for reference: 23-0351, 22-0274 • **Start up sequence**: Toggle the hopper switch to "on," turn the drive motor to on, turn the glycol pump on, ensure your speed is set (fast or slow) and then open the feed control levers. • **Shut down sequence:** Close the feed control levers (ensure they are in a completely horizontal position), visually verify that the device is no longer dispensing spheres and then turn off the glycol pump, drive motor and hopper. • **If a jam occurs, immediately turn off the motor to prevent damage**. Pull the manual assist wheel outward to disengage the motor and rotate the wheel forward and backward until the device is cleared. Ensure start up sequence is followed to prevent additional malfunctions with the device. When the helicopter stays within the burn unit or crosses a fire control line with the intent of returning for another live firing run, the device doesn't need to be secured. **If leaving the burn unit, the device will be completely shut off and deactivated.** Best Practice: The operator's right hand must remain on the feed control levers in the closed position**.**

	Unit 5—Flight Preparation (Premo Mark III) and Inflight Procedures
#13	**Flight Preparation** The operational briefing should cover: • Objectives • Organizational structure and personnel assignments • Review of the Air Ops. Summary (if applicable) or other aircraft status reports • Weather and predicted fire behavior • Communication plan • Hazards and emergency landing areas • Medical plan • Crash rescue plan and assignments **Instructor Note:** Refer to the 5700 for required elements for Aerial Ignition for RX and Incidents

	Unit 5—Flight Preparation (Premo Mark III) and Inflight Procedures
#14	**Flight Preparation** This slide goes over the importance of re-inspection before operations. **INSTRUCTOR NOTE:** This slide is specific to USFS operations. However, is a safety practice all helicopter aviation operators should consider. **Reference Forest Service Aviation Safety Alert FSSA 18-03** 2018 East River helicopter accident – A doors off helicopter tour of New York City with an A-Star had passengers in secondary restraints; passengers were taking pictures out the open doors when a secondary restraint inadvertently snagged on the fuel shut off, which was located on the floor, and cut fuel to the aircraft. The aircraft pop-out floats failed to fully inflate, and the aircraft was quickly submerged, the pilot was able to egress, but the passengers on board were unable to release their secondary restraint and were killed in the submersion. This accident led to a list of mitigation recommendations to prevent similar incidents in the future when conducting doors off/doors open operations, **these mitigations at a minimum require:** • Ensure aircraft connection point and secondary restraint configuration (IASA 17-02 https://www.doi.gov/sites/doi.gov/files/uploads/iasa_2017-02.pdf) • Proper donning and adjustment of secondary restraint systems • Understanding of the secondary restraint interaction with FAA approved seatbelt • Location and use-of the secondary restraint quick-release mechanism(s) • Utilize the buddy-check process to confirm proper configuration and connection (double-check/re-inspection) • Egress training (secondary restraint quick-release mechanism, removal of seatbelt, exiting aircraft) • Location and use of rescue knife (seatbelt/webbing cutter) • Any time a secondary restraint is utilized it must remain free of all flight controls and switches

	Unit 5—Flight Preparation (Premo Mark III) and Inflight Procedures
#15	**Pre-Burn Recon and Dry Run** This slide goes over the importance of a pre-burn and dry run. During the dry run, positive CRM must be established. All personnel should discuss the aircraft's capabilities and limitations during all phases of flight operations – ensure aircraft altitude, speed, wind direction, the HOGE power check and emergency helispots/LZs are discussed before completing a dry run of the first firing sequence. After the dry run, the flight crew will evaluate the risk assessment mitigations and readjust as necessary.
#16	**Dry Run** The audio in the video demonstrates some of the communication that may occur, both in the cockpit and with ground personnel during the initial dry run.
#17	**Ignition Operations** • Follows direction of the aerial ignition supervisor This is unless there are factors that will effect helicopter performance. • PLDO monitors device operations and refills as needed • Communicates necessary adjustments to the pilot In the briefing and dry run, is a great time to establish communication expectations. • Verifies ignition is occurring Fuels may have a delay in ignitions. • Troubleshoots as required Troubleshooting could be device specific, firing patterns to get the desired effect, etc.
	Unit End

	Unit 5— Flight Preparation (Red Dragon) and Inflight Procedures
#1	**Unit Objectives** • Demonstrate knowledge of the operational functions before, during, and after the mission • Demonstrate knowledge of the firing commands and actions of a PLDO

	Unit 5— Flight Preparation (Red Dragon) and Inflight Procedures

#2	**Personnel Preparation**
	• **Attend briefing**
	If the PLDO cannot attend the operations briefing the aerial ignitions supervisor may provide the briefing to the PLDO.
	• **Aircraft safety briefing**
	As part of the aircraft safety briefing, the aerial ignitions supervisor should receive a detailed briefing on the aircraft radio and mixer panel operations. All personnel should also discuss sterile cockpit procedures and work to develop positive (CRM) prior to and throughout the flight.
	• **Recon flight**
	If space allows on the recon flight, prior to ignitions, the PLDO should be a part of the recon flight. During the recon flight personnel will:
	  • Review the unit boundaries
	  • Discuss hazards and flight profiles
	  • Identify emergency landing locations near the burn unit
	• **Pre-Mission briefing**
	Before the first flight, all aerial ignition and helicopter personnel at the helibase or helispot will complete a briefing. Items discussed during the pre-mission briefing include:
	  • Responsibilities and assignments
	  • Crash rescue and emergency response
	  • Communications – tracking and/or flight following
	  • Aircraft reconfiguration for bucket work
	  • Communications – frequencies, flight following procedures and identifiers
	  • Environmental concerns such as weather and fire behavior
	  • Review manifests, load calculations, weight and balance, emergency procedures and PSD commands
	Review of the Mission Aviation Safety Plan (MASP) / Project Aviation Safety Plan (PASP) and completion of the Go No-Go Checklist and risk assessments.

	Unit 5— Flight Preparation (Red Dragon) and Inflight Procedures
#3	**Aircraft Preparation** Work with pilot and mechanic on prep of the aircraft. • Remove all loose items – may include seat cushions • Remove rear door • Install tether/harness • Protect the aircraft door sill and paint • Handheld radio on board (Best Practice) • Fire shelters inside the aircraft, for all on board.
#4	**Bench Test – Premo Mark III and Red Dragon** • **Ensure all personnel involved are wearing the proper PPE** • Clear area of flammables and non-essential personnel • Fill the device with glycol and water • Connect the power cord to the proper power supply. • Place a metal container under chute; do not add water. Water in the metal container may cause the sphere to not to ignite or delay reaction time. *If two devices are available, consider bench testing both devices. **Instructor Note:** Have device manual available to reference. Consider having the device out for some hands-on bench testing.
#5	**Bench Test – Premo Mark III and Red Dragon** This slide has video with prep for bench testing and bench testing, for both devices. **Instructor Note:** If teaching to one device reference the slide notes for time stamps.
#6	**Bench Test – Red Dragon** **Instructor Note:** Refer to the device manual. If device manual differ from best practices, point out the subtle differences.

	Unit 5— Flight Preparation (Red Dragon) and Inflight Procedures
#7	**Bench Test – Red Dragon** This slide continues to the controller portion of bench testing the Red Dragon. Temperature and humidity may affect ignition delay, causing delays to be greater than 20 seconds.
#8	**Red Dragon Installation** Work with pilot and mechanic when installing device. Each aircraft has subtle differences that the pilot and mechanic can help address. **Instructor Note:** Either explain the installation process to students referencing this slide or proceed to the next slides and play the installation videos.
#9	**Installation – Red Dragon- ASTAR** Video goes over the device installation in the ASTAR.
#10	**Installation – Red Dragon– Bell Medium** Video goes over the device installation in the Bell Medium.
#11	**Installation – Red Dragon– Bell 206/407** Video goes over the device installation in the Bell 206/407.

	Unit 5— Flight Preparation (Red Dragon) and Inflight Procedures
#12	**Flight Preparation** Personnel onboard the helicopter shall be limited to essential personnel. Additional occupants may include instructor or trainees if essential to the mission. • Ensure all equipment is installed properly • Helicopter's electrical system has been tested • Additional gallon of water secured in the aircraft within reach of PLDO • Review sphere spacing/ Device settings (i.e., 4 on Red Dragon = Mark III) • Conduct a review of commands and actions with aerial ignitions supervisor, PLDO, and pilot • Ensure bucket is operational and ready for reconfiguration Best Practice: If there is only one aircraft available for burn, prep bucket for potential suppression needs.

	Unit 5— Flight Preparation (Red Dragon) and Inflight Procedures

#13	**Red Dragon Firing Commands and Response**
	
	INSTRUCTOR NOTE: Prior to class, search for PSD SAFECOMs filed related to PSD commands/responses. To relay the importance of all parties Aerial Ignitions Supervisor, PLDO and the pilot, understanding the commands and response required.Past SAFECOMs for reference: 23-0351, 22-0274
	
	• **Start up sequence**:
	  • Set the "RUN/STOP" toggle on the main control panel to "RUN." The system status lights should illuminate, and the hopper motor should activate.
	  • Set the "SPEED" switch on the tethered remote control to the desired setting.
	  • Enter the first flight line at operational speed and set the feed gate toggle on the tethered remote control to "OPEN." The drive motor should activate.
	• **Shut down sequence:**
	  • When the feed gate toggle is set to “CLOSE,” the spheres already within the injection head will continue to be primed and ejected until the head is clear of all spheres at which time the drive motor will stop. Visually verify that the device is no longer dispensing spheres and then turn off the glycol pump, drive motor and hopper.
	  • Ensure that the feed gates are closed.
	  • Toggle the "RUN/STOP" switch to "STOP."
	  • Ensure that no spheres remain in the injection head.
	• **If a jam occurs, immediately turn off the motor to prevent damage**. Pull the manual assist wheel outward to disengage the motor and rotate the wheel forward and backward until the device is cleared. Ensure start up sequence is followed to prevent additional malfunctions with the device.
	
	When the helicopter stays within the burn unit or crosses a fire control line with the intent of returning for another live firing run, the device doesn’t need to be secured. **If leaving the burn unit, the device will be completely shut off and deactivated.**

	Unit 5— Flight Preparation (Red Dragon) and Inflight Procedures
#14	**Flight Preparation** This slide is to go over the different discussions and briefings that should be gone over before operations. The operational briefing should cover: • Objectives • Organizational structure and personnel assignments • Review of the Air Ops. Summary (if applicable) or other aircraft status reports • Weather and predicted fire behavior • Communication plan • Hazards and emergency landing areas • Medical plan • Crash rescue plan and assignments **Instructor Note:** Refer to the Aerial Ignition Guide PMS 513, and agency policy.

	Unit 5— Flight Preparation (Red Dragon) and Inflight Procedures
#15	**Flight Preparation** This slide goes over the importance of re-inspection before operations. **INSTRUCTOR NOTE:** This slide is specific to USFS operations. However, is a safety practice all helicopter aviation operators should consider. **Reference Forest Service Aviation Safety Alert FSSA 18-03** 2018 East River helicopter accident – A doors off helicopter tour of New York City with an A-Star had passengers in secondary restraints; passengers were taking pictures out the open doors when a secondary restraint inadvertently snagged on the fuel shut off, which was located on the floor, and cut fuel to the aircraft. The aircraft pop-out floats failed to fully inflate, and the aircraft was quickly submerged, the pilot was able to egress, but the passengers on board were unable to release their secondary restraint and were killed in the submersion. This accident led to a list of mitigation recommendations to prevent similar incidents in the future when conducting doors off/doors open operations, **these mitigations at a minimum require:** • Ensure aircraft connection point and secondary restraint configuration (IASA 17-02 https://www.doi.gov/sites/doi.gov/files/uploads/iasa_2017-02.pdf) • Proper donning and adjustment of secondary restraint systems • Understanding of the secondary restraint interaction with FAA approved seatbelt • Location and use-of the secondary restraint quick-release mechanism(s) • Utilize the buddy-check process to confirm proper configuration and connection (double-check/re-inspection) • Egress training (secondary restraint quick-release mechanism, removal of seatbelt, exiting aircraft) • Location and use of rescue knife (seatbelt/webbing cutter) • Any time a secondary restraint is utilized it must remain free of all flight controls and switches

	Unit 5— Flight Preparation (Red Dragon) and Inflight Procedures
#16	**Pre-Burn Recon and Dry Run** This slide goes over the importance of a pre-burn and dry run. During the dry run, positive CRM must be established. All personnel should discuss the aircraft's capabilities and limitations during all phases of flight operations – ensure aircraft altitude, speed, wind direction, the HOGE power check and emergency helispots/LZs are discussed before completing a dry run of the first firing sequence. After the dry run, the flight crew will evaluate the risk assessment mitigations and readjust as necessary.
#17	**Dry Run** The audio in the video demonstrates some of the communication that may occur, both in the cockpit and with ground personnel during the initial dry run.
#18	**Ignition Operations** • Follows direction of the aerial ignition supervisor This is unless there are factors that will effect helicopter performance. • PLDO monitors device operations and refills as needed • Communicates necessary adjustments to the pilot In the briefing and dry run, is a great time to establish communication expectations. • Verifies ignition is occurring Fuels may have a delay in ignitions. • Troubleshoots as required Troubleshooting could be device specific, firing patterns to get the desired effect, etc.
	Unit End

	Unit 6—Fuels and Fire Behavior
#1	**Fuels and Fire Behavior** This unit goes over how fuels, fire behavior and aerial ignitions interact with each other. Objectives: • Identify key elements of the fire environment • Review the three factors that drive fire behavior **Instructor Note:** Keep your student's experience in mind when teaching this unit.
#2	**Fuels and Fire Behavior** Fuels, weather, topography and ignition patterns interact to create fire effects. Adjustments to firing patterns can be made to produce fire effects that will meet burn objectives. It is important to recognize that PSD spheres' burn time is limited, and each spheres' burn intensity relatively low. Consideration of fuel characteristics is important for determining whether PSD is the correct tool for the job or how the tool will be used. <u>Fuel Characteristics</u> • Fuel type Different fuel types in different regions have different parameters. • Fuel moisture If fine fuels are not available or fine fuel moisture codes (FFMC) are high, PSD operations may have hampered fire effects. • Fuel load and continuity Without continuous receptive fuels the spheres will be unable to grow together and develop. This could potentially limit spread and intensity. This is where spacing of spheres may be a consideration and or altered during operations. • Chemical properties Some fuels have a high oil component, i.e. palmetto, manzanita, etc. which can alter fire behavior.

	Unit 6—Fuels and Fire Behavior
#3	**Fuels and Fire Behavior – Firing Techniques** **Ignition /sphere spacing is determined by the aircraft's forward airspeed and altitude, the number of chutes (Premo Mark III), device speed (Premo Mark III – fast or slow, Red Dragon speeds 1 through 7), and wind speed and direction.** When reviewing firing patterns ensure these factors are discussed with the aerial ignition supervisor. When going over firing techniques, reducing time in the "low and slow" should also be considered. • **Strip or Head fire** – a fire spreading with the wind or the slope. Highest intensity fire with long flame lengths, fast rate of spread, rapid heat buildup with substantial convection column, and shorter heat residence time than that of a backing or flanking fire. Spheres are laid in line of the wind and/or slope to so the fire could be pushed them. • **Backing –** a fire that is spreading against the wind or slope. Lowest intensity fire, smaller flame lengths, slowest rate of spread but longer heat residence time than a head or flanking fire. Spheres are placed so the fire can back into the wind or down the slope. • **Flanking –** a fire that spreads at right angles (perpendicular) to the wind or slope. A flanking fire has a slower rate of spread and lower intensity than a head fire, but it has a higher rate of spread with higher intensity than a backing fire. It has an intermediate heat residence time. • **Ring –** Lighting fire in a circular pattern around a specific object to minimize or exclude fire impact on the object. Or lighting fire in a circular pattern so the fire front converges towards the center, "ringing the unit." • **Spot / Dot –** Igniting "dots" of fire (i.e., Premo Mark III two chutes and set to slow or Red Dragon on speed 1-2) to regulate intensity (increased or decreased). • **Chevron –** A variation of strip-head or flanking fire in which the strips resemble a V. This technique may be used to burn down a ridgeline or to widen a control line. • **Center –** Lighting fire in a circular fashion for the inside or high point of an area in an outward progression. Quickly generates high intensity fire. Typically utilized when winds are calm or light, and sufficient fuel loading is available.

	Unit 6—Fuels and Fire Behavior
#4	**Fuels and Fire Behavior** By spacing the spheres both with the ignition line and spacing between the ignition lines, we can manipulate fire behavior. When sphere spacing is kept tight together, there is limited space for the fire to accelerate. This spacing creates a low rate of spread and low intensity fire. A great example of this is the picture on the previous slide. The spheres were kept close together by running the Premo Mark III was at 4 fast, and ignition lines were kept tight by flying narrower strips. This burn was completed near a road utilized as a holding line. This type of ignition allowed personnel to build "black" along the holding line while lowering fire intensities. This helps the ground resources hold the line.
#5	**Fuels and Fire Behavior** In the diagram on the left, the ignition lines are spaced further apart. This allows the fire to accelerate and develop, leading to greater fire intensity. The line spacing and sphere spacing have been increased in the diagram on the right, leading to more significant development and fire intensity than shown in the diagram on the left. Operators, aerial ignition supervisors, and burn bosses understand this concept, and realize that PSD ignitions take time to develop. It is easy to be tricked into putting too much fire on the ground if aerial ignition supervisors are not patient and do not allow the spheres to develop.
#6	**Fuels and Fire Behavior** **Instructor Note:** Hide this slide if you are not training on the Premo Mark III. This chart shows ignition (sphere) spacing as it relates to the aircraft's groundspeed, number of feed chutes open, and motor speed (fast or slow). Consider reviewing the chart with the PLDO, AIS, and pilot before operations.

	Unit 6—Fuels and Fire Behavior
#7	**Fuels and Fire Behavior** **Instructor Note:** Hide this slide if you are not training on the Red Dragon. This chart shows sphere spacing related to the aircraft's ground speed and selected device speed. Consider reviewing the chart with the PLDO, AIS, and pilot before operations.
#8	**Example Burn Sequence** This diagram shows a 2,359 acre burn unit and the order of ignition lines completed (numbered 1 through 21). The ambient wind direction on the burn was from the SW. **Instructor Note:** Use the diagram to point out different firing patterns, the fire effects, and why.
	Unit End

	Unit 7— Device Malfunctions and Emergency Procedures
#1	**Device Malfunctions and Emergency Procedures** This unit will go over common device malfunctions and emergency procedures. Objectives: • Identify device malfunctions • Demonstrate knowledge of emergency procedures
#2	**Device Malfunctions and Terminology** The PLDO, aerial ignitions supervisor, and pilot must understand the terminology used for device malfunctions so that appropriate response actions may be taken. • **Clog** - When a sphere does not transfer from the hopper to the feed chute. A jam can be identified through through the sight glass. • **Jam** - When a plastic sphere is stuck inside the device, usually at the slipper blocks. • **Hang Fire** - The progression of a jam that initiates a fire inside the device. Often, a hang fire is the results from a loss of power to the device; a sphere has been injected and is now unable to be automatically dispensed from the device. Or the PLDO cannot clear a jam before the sphere ignites. • **Loss of Power -** The device loses electrical systems and quits working.
#3	**PLDO Device Terminology** There is a video showing a clog. Have the students identify the issue.
#4	**Hang Fire** This is a demonstration of what a hang fire looks like. It also demonstrates the emergency water doing its job.

	Unit 7— Device Malfunctions and Emergency Procedures
#5	**Premo Mark III Device Malfunction** **Instructor Note:** Hide slide if you are not teaching the Premo Mark III This slide goes over some ways to identify a malfunction and procedures to follow. • The PLDO will be alerted to a problem in several ways: • During a jam, the manual hand wheel may stop turning even though the feed gates are open. • The PLDO may hear the manual handwheel “pop” out of position and/or see the handwheel out of position. • Spheres are no longer seen flowing through the chutes sight glass. • The smell of chemical burning is an alert to a hang fire. In the event of a malfunction: • PLDO notifies pilot of problem and provides brief description • Pilot keeps the aircraft in burn area until issue is resolved. • PLDO closes chute feed handles. • If device is jammed, immediately turn off drive motor, pull manual assist wheel outward and rotate it several revolutions forward then backward. ○ If the obstruction clears, turn on the drive motor, check circuit breaker, and notify the pilot and the aerial ignitions supervisor before resuming. • In the case of a hang fire, activate the emergency water system for up to 30 seconds. • If necessary, use the additional water to extinguish the fire by pouring it down the hopper into the feed chutes. If a problem persists, notify the pilot. • Land as soon as possible. Once the device is cleared, ensure start up sequenced is followed to prevent additional malfunctions.

	Unit 7— Device Malfunctions and Emergency Procedures
#6	**Premo Mark III Emergency Procedures** **Instructor Note:** Hide slide if you are not teaching the Premo Mark III This is a video going over emergency procedures in the event of a device malfunction.

	Unit 7— Device Malfunctions and Emergency Procedures

#7	**Red Dragon Device Malfunction**
	Instructor Note: Hide slide if you are not teaching the Red Dragon
	
	The PLDO will be alerted to a problem in several ways:
	• The “FAULT” indicator light on the control will flash.
	• The “MOTOR FAULT” indicator on the main control panel will illuminate.
	• The manual hand wheel may briefly pause and reverse directions, then resume normal revolutions.
	• The manual hand wheel may stop turning even though the feed gates are open.
	• Spheres are no longer flowing through the chute.
	• The smell of chemical burning is an alert to a hang fire.
	In the event of a malfunction:
	• If automatic clearing fails, notify the pilot of the situation.
	• Pilot maintains aircraft in burn area until emergency is resolved.
	• Press the manual feed control knob to close the feed gates and turn off power.
	• Rotate the manual hand wheel in the reverse and forward directions to clear the jam.
	• If jam cannot be cleared and sphere ignition occurs:
	  ○ Toggle the water switch to the “ON” position and hold until the combustion has stopped.
	  ○ If necessary, pour the additional container of water into the hopper.
	• Land as soon as possible
	Once the device is cleared, ensure start up sequenced is followed to prevent additional malfunctions.

	Unit 7— Device Malfunctions and Emergency Procedures
#8	**Red Dragon Emergency Procedures** **Instructor Note:** Hide slide if you are not teaching the Red Dragon. This is a video going over emergency procedures in the event of a device malfunction.

#9	**Aircraft Emergency Procedures** This unit goes over key points and verbiage to go over in aircraft emergency procedures. **Instructor Note:** Refer to *Device Malfunctions and Emergency Procedures* in the *NWCG Standards for Aerial Ignition.* All involved in operations should conduct a thorough flight briefing to identify roles and responsibilities, establish crew resource management, understand expectations, flight management responsibilities, protocols, and when the variant landing criteria would be exercised. The flight brief should clearly delineate individual crew actions and the communication criteria to initiate action. **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 near-term catastrophic failure. **Land as soon as possible** – This is where 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/practicable –** This is where an emergency allows time to manage it and where flight safety is not critically compromised. However, a landing without delay should be made at the nearest site where a safe landing can be reasonably accomplished. **Aviate** – Managing the aircraft is the most critical and number one priority; fly the aircraft. Place the aircraft in a less critical environment. Do not move on to navigate or communicate until doing so. **Navigate** – A discussion of egress options, routes, landing site criteria, and site selection should be conducted. This is so crew understand the difference between land immediately, land as soon as possible, and land as soon as practicable sites. Egress of the project area and conditions for egressing, such as verification that the PSD device has been secured to prevent ignition outside the burn boundaries. Egress routes should be discussed to identify possible enroute landing sites and hazards. **Communicate –** In what way or how are emergencies going to be initially communicated to flight crewmembers and ground

	Unit 7— Device Malfunctions and Emergency Procedures
	personnel? Discussion should occur regarding who communicates what, to whom, when and how. This is especially critical when an emergency may prevent the pilot from managing cockpit radio switches. Key words or phrases should be discussed. There will likely not be enough time to communicate for some more catastrophic emergencies. It should be discussed what to be done in those situations. The briefing should also include information critical to crew survival after landing and there should be an awareness to the incident or project leadership.

#10	**Aircraft Emergency Procedures – Crew Response**
	There are many circumstances that can constitute an in-flight emergency. During an emergency is NOT the time to figure out how to respond to an emergency; this is done through pre-planning, briefings, and trainings.
	These topics should be discussed prior to flight to establish a set of procedures so that they do not need to be addressed in flight, especially if the emergency prevents the ability to communicate effectively or there is little time to respond to the emergency.
	• Management of common aircraft and equipment malfunctions
	• Consideration for jettison and management of equipment
	• Survivability considerations – pre and post-crash
	  • Repositioning seating
	  • Secondary restraint connections
	  • Egressing the aircraft
	  • Survival equipment and manual ELT activation
	  • Onboard fire extinguisher use

#11	**Aircraft Emergency Procedures – Crew Response** Immediate Response Actions outlined
#12	**Aircraft Emergency Procedures – Crew Response** Delayed Response Actions outlined
#13	**Emergency Procedures - Crash Positions** This video goes over crash positions while the PSD is on board. Things the PLDO needs to consider and practice.

	Unit 7— Device Malfunctions and Emergency Procedures
#14	**Device Malfunction or Aircraft Emergencies** In the event of a device malfunction or aircraft emergency, a SAFECOM should be filed. It should be documented what occurred, any remedial actions taken, and attach pictures as appropriate. When filing a SAFECOM on spheres, include the manufacturer information (box manufactured, lot number, etc.). **Filing a SAFECOM does not replace the need for immediate onsite action.**
#15	**Unit 8 - Field Session** Unit Objectives: • Complete a bench test of the device following all safety measures • Accurately respond to mock device malfunctions • Properly respond to mock emergency scenarios