

**SEI**  
INDUSTRIES

**DRAGON**<sup>®</sup>  
FIRE IGNITION PRODUCTS

# ***RED DRAGON OPERATIONS MANUAL***

***2013 VERSION E***

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## **RED DRAGON OPERATIONS MANUAL - Version E**

**Issue Date: JULY 2013**

**PLEASE READ BEFORE USING.**

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## Section 1: Dragon System Overview

The use of controlled, prescribed or back burning techniques provide an effective tool in the ongoing commitment to forest and wildland management. Helicopter-deployed aerial ignition devices (AIDs) have a lengthy, proven track record of providing a means of initiating these burns in an efficient, safe and controllable manner.

SEI's Dragon Division presents the next generation of AID – the Dragon Egg – and its associated aerial dispenser, the Red Dragon. This manual details the operation and field maintenance of the Red Dragon from SEI Industries Ltd.

### Dragon Eggs

Dragon Eggs are small, 26 mm diameter, two colour (orange/white), aerial ignition spheres made of high impact polystyrene (HIPS) plastic filled with three grams of potassium permanganate.

In this state, the eggs are stable provided the shells remain undamaged. When injected with ethylene glycol (anti-freeze), an exothermic reaction initiates. After a delay of approximately 30 seconds, combustion commences with white smoke being expelled from the needle hole followed by sphere ignition. Once ignited, the plastic shell is consumed as fuel. The total combustion time, following ignition, is about 80 seconds.



The Red Dragon injects a constant volume of glycol into each Dragon Egg regardless of the drop rate set by the operator. As such, the auto-ignite delay time is influenced primarily by the temperatures of the Dragon Eggs and glycol. The indicated delay times are based on air/sphere temperatures of 50 –70 degrees F (10 – 20 degrees C). Increased temperatures will decrease the delay time. By diluting the glycol with water to a 50/50 mix, the delay time can be increased.

The Dragon Egg offers a number of key advantages including:

*Ignition reliability* – Dragon Eggs are an exceptionally reliable source of ignition.

*Enhanced storage capacities* – Small dimensions maximize hopper and shipping container capacity.

*Enhanced aerodynamics* – High terminal velocities minimize “kiting” and maximize forest penetration.

*Enhanced visibility* – Dual contrasting colors render the Dragon Egg highly visible.

## Red Dragon Dispenser

The Red Dragon Dispenser, developed by SEI Industries Ltd., represents the next generation of aerial sphere dispensers. The primary function of the Red Dragon dispenser is to inject a measured amount of ethylene glycol into Dragon Eggs, thereby initiating an exothermic reaction, and then expel the primed spheres from the aircraft.

### *Operational Features*

- Seven drop rates from 25 – 175 spheres per minute.
- Tethered remote control to adjust the drop rate and control the feed gates.
- Positive displacement glycol pumps ensure constant glycol volume regardless of drop rate.
- Smart software minimizes the chance of sphere jams occurring when feed gates open.
- Re-settable sphere counter.
- Large capacity hopper holds 650 spheres.
- Removable base to fit various helicopter configurations.
- Tank drain valves.

### *Safety Features*

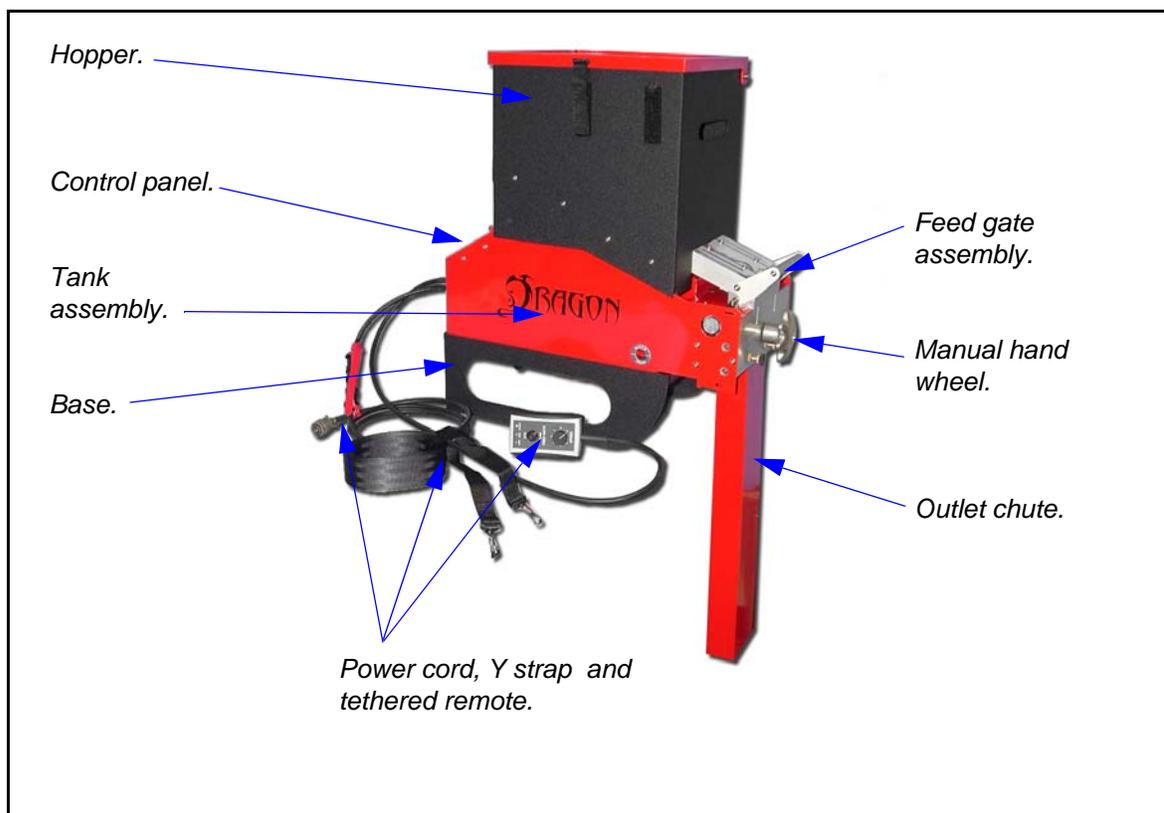
- Automatic jam detection and clearing system.
- Manual hand-wheel to clear a jam when no power is available.
- Emergency water pump with battery backup power supply.
- Low water interlock to prevent start up when the emergency water supply is low.
- Manual override to close and lock the feed gates.
- Quick release hopper to permit ejection of the hopper and the unused spheres in an emergency.



### Standard Components

The Red Dragon dispenser consist of a number of major components:

- **Hopper** – Stores the unprimed spheres.
- **Feed Gate Assembly** – Controls the flow of spheres into the injection head.
- **Injection Head** – Injects the spheres with glycol.
- **Outlet Chute** – Directs the spheres from the injection head to a point below the aircraft.
- **Tank Assembly** – Contains the water and glycol tanks and acts as the frame for the unit.
- **Control Panel** – Houses the control board, control switches and indicators.
- **Tethered Remote Control** – Controls the feed gates and drop rate.
- **Power Cord** – Connects dispenser to aircraft's auxiliary power system.
- **Base Mounting System** – Secures the unit to the aircraft.



### Mounting System

The standard base supplied with the Red Dragon allows the unit to be installed into a Bell series 206 helicopter. The base may be removed to allow the installation into other helicopters featuring a flat cabin floor.

The Red Dragon is secured into the helicopter using a “Y” strap that is adjustable to fit a range of cabin widths.



### Tank Assembly

The tank assembly houses the water and glycol tanks. It also acts as the framework to which the other components are mounted. The water and glycol systems have color-coded filler breather caps. The caps have integral strainers to prevent contamination.

Each tank is also fitted with a drain valve which can be operated using a slotted screwdriver. A short length of tubing attaches to either drain valve to direct the fluid into a suitable container.

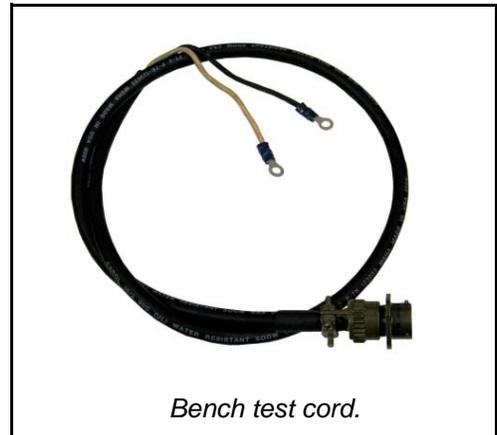


### Power Cords

The standard power cord is a 15 ft. jacketed cable fitted with an MS3116F-12-3P plug to connect to the aircraft's 28 VDC power supply (Pin A +28VDC, Pin B GND). The other end of the power cord terminates in a receptacle. A short pigtail cord from the machine's front panel has a mating plug.



A bench test power cord is also provided. One end of the cord is provided with a receptacle to connect to the pigtail cord on the main control panel. The other end of the cord is fitted with 1/4" ring terminals for attachment to an external power supply/battery for bench test purposes.



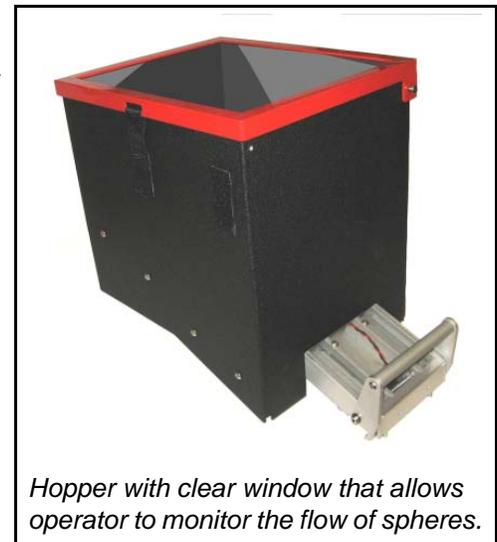
### Hopper

The hopper provides storage capacity for 650 Dragon Eggs and can be filled by the operator before or during operation. An agitator within the hopper provides a constant supply of spheres to the feed gates via two chutes.

The chutes have a clear window to allow the operator to monitor the flow of spheres from the hopper. Secondary stops, located at the outlet of the chutes, automatically close and stop the flow of spheres when the hopper is removed from the dispenser.

The hopper has a hinged lid which may be configured so that it opens towards or away from the operator. A clear polycarbonate window allows the operator to monitor the level of spheres in the hopper.

Power to the hopper is provided through a multi-pin connector that automatically mates when the hopper is placed onto the feed gate assembly. In an emergency, the hopper can be quickly removed by grasping the locking handle and lifting upwards.



### Important Note

With the lid removed, the Dragon eggs are stable in the hopper under normal flight conditions. The operating authority may decide to permanently remove the lid to facilitate filling operations.

### Feed Gate Assembly

The feed gate assembly controls the flow of spheres from the hopper into the injection head. As the spheres exit the hopper, they enter two vertical passages in the feed gate assembly.

Each passage has a feed gate attached to a common control rod. Pushing the rod inwards causes the feed gates to block the passages and stop the flow of spheres.

In normal operation, the position of the feed control rod and the feed gates is controlled by two solenoids, under direction, from the main controller.

To close the gates, the close solenoid energizes and pushes the rod inwards.

When the rod is fully inwards, a spring-loaded pin locks into a groove in the rod to prevent it from opening. The close solenoid then de-energizes.

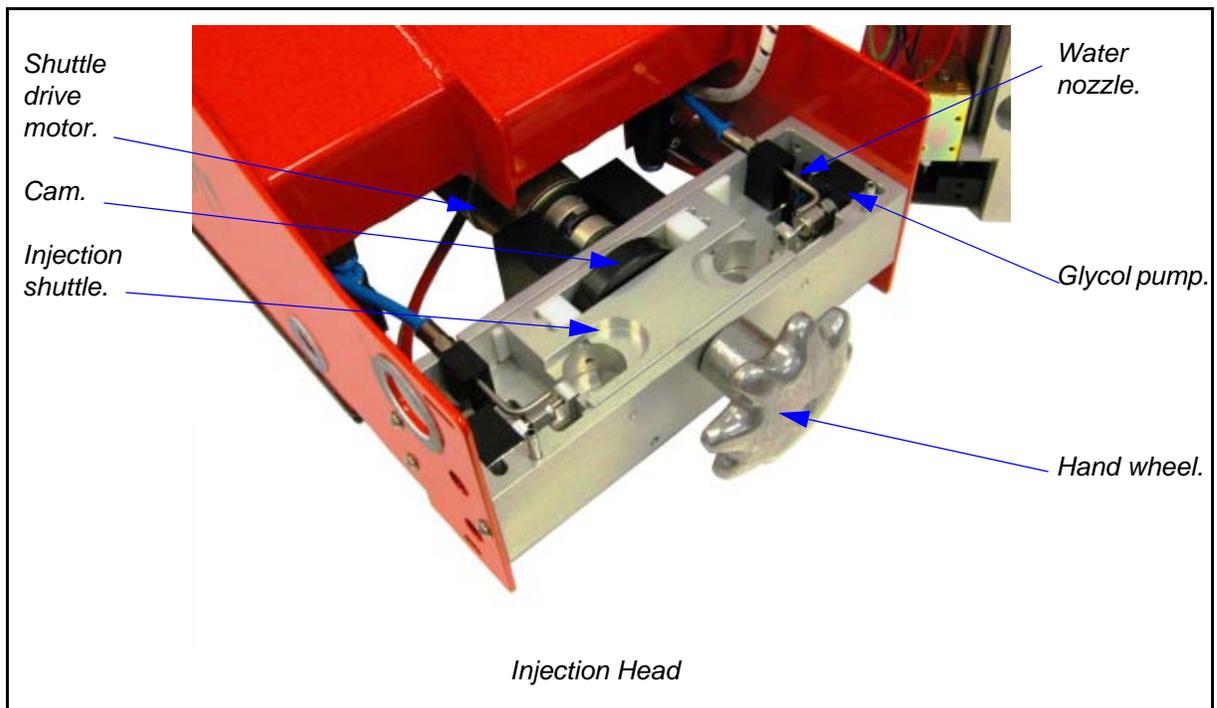


To open the gates, the open solenoid energizes and pulls out the locking pin. An opening spring on the feed control rod causes it to move outwards into the fully open position. The open solenoid then de-energizes.

There is a manual feed gate knob located on the end of the control rod. In an emergency, pushing on the knob will also close and lock the feed gates. The feed gates cannot be opened manually.

The feed gate assembly is located on top of the injection head by two vertical pins. It is held in place by two manual locking cams. It can be quickly disconnected from the injection head to allow access for cleaning.

## Injection Head

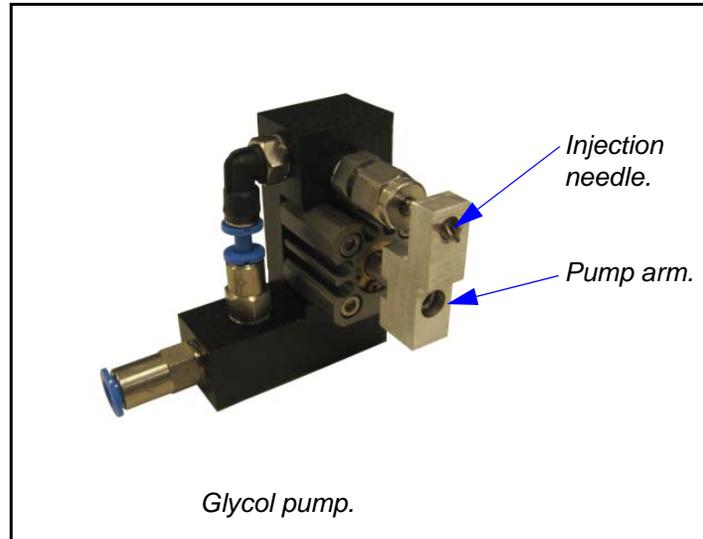


The injection head is the heart of the Red Dragon Dispenser. It is here that the Dragon Eggs are pierced by a hollow needle, injected with a controlled amount of glycol and then ejected from the machine.

The injection shuttle is located in the head. The shuttle guides the spheres as they pass through the injection head. The shuttle is driven in a reciprocating motion by a DC motor and a single offset cam. As a sphere exits the feed gate assembly, it falls into one of two cavities in the injection shuttle. Outward motion of the shuttle causes the sphere to contact the injection needle and be punctured. As the shuttle moves further outward, the sphere presses against the pump arm causing a controlled amount of glycol to be injected into the sphere.

The shuttle then reverses direction, extracting the sphere from the injection needle. It passes through the center position and continues to its full inward position. At that position, the cavity is over the exit chute, and the primed sphere drops from the shuttle and exits the machine. The two shuttle cavities are arranged such that when one side is injecting a sphere, the other side is dropping a sphere down the exit chute. This gives a steady output of spheres from the machine.

The glycol pumps are a constant displacement type which deliver the same quantity of glycol on every stroke regardless of the drop rate. This eliminates the need for the operator to calibrate the glycol system. When no sphere is present, the pump arm is not activated and no glycol flows.

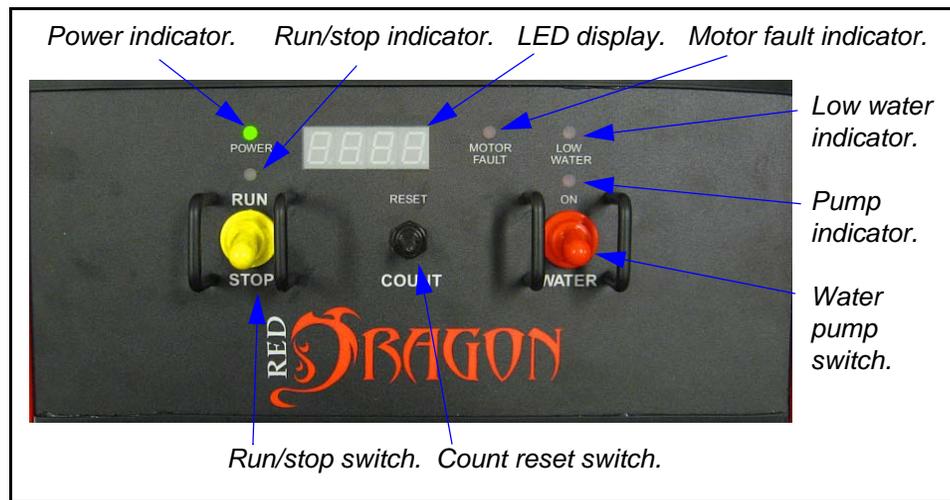


If the machine is operated until the glycol pumps drain the tank, the pumps will lose their prime. The pump assemblies may be removed from the injection head and re-primed by squeezing the pump arm repeatedly until glycol flows from the injection needle. Each pump assembly is secured to the injection head by two captive screws.

The injection head also includes two water nozzles directed into the injection chambers. These nozzles are connected to a water pump and reservoir. In an emergency, the water pump can be activated by the operator to extinguish a fire in the injection chambers.

The machine is equipped with 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 lose electrical power, a handwheel is fitted to the outboard end of the drive shaft. This handwheel can be used to turn the drive motor and cam in either direction to clear a jammed or broken sphere.

## Control Panel



The control panel is the brains of the Red Dragon system. A single circuit board mounted beneath the main control panel contains the microprocessor and all additional components.

The green “POWER” indicator on the main control panel illuminates when the machine is connected to an external power source. External power to the machine is routed through a 5A, type MS3320 manually resettable circuit breaker which is located on the vertical front panel below the main control panel. Pulling the breaker out cuts all external power to the machine.

The “RUN/STOP” toggle switch controls the operation of the hopper and the shuttle drive motor. When the switch is set to the “RUN” position, the hopper drive motor starts and the yellow indicator above the switch illuminates. The shuttle drive motor does NOT start at this time.

Operation of the shuttle drive motor is controlled by the feed gate switch on the tethered remote control. With the “RUN/STOP” switch in the “RUN” position and the feed gate switch toggled to the “OPEN” position, the feed gates open, and the shuttle drive motor starts. When the feed gate switch is toggled to the “CLOSE” position, the feed gates close but the shuttle drive motor continues to run for two more revolutions to purge the shuttle of any primed spheres. After the purge, the drive motor stops.

The feed gates and shuttle drive motor cannot be activated when the “RUN/STOP” switch is in the “STOP” position. However, if the switch is moved to the “STOP” position when the feed gate is open and the shuttle drive motor is already running, the feed gates will close and the motor will purge for three revolutions and then shut down.

The controller measures the actual speed of the shuttle drive motor and can determine when a jam condition has occurred in the injection shuttle. When the controller senses that a jam has occurred, the “MOTOR FAULT” indicator illuminates and the controller adjusts the shuttle drive motor direction and speed to automatically clear the jam. Once the jam is cleared, the unit returns to normal operation.

The momentary “WATER” toggle switch controls the emergency water pump. When the pump is activated, the indicator above the switch illuminates. The pump normally receives its power from the external power supply. However, if the unit loses external power, there is a battery backup that supplies power to the emergency water pump.

This battery is constantly charging when the unit is connected to an external power supply. If the unit has been stored for a long period of time and the battery has lost its charge, the warning message “bAtt” will flash on the LED segment display. The low battery condition WILL NOT prevent operation of the Red Dragon. (On older Red Dragon dispensers, with serial numbers from 101-117, there is a battery isolation switch located on the underside to prevent battery discharge over time.)



There is a water level sensor located in the water tank. The “LOW WATER” indicator will illuminate when there is insufficient water in the tank for the machine to safely operate. The shuttle drive motor WILL NOT start when the “LOW WATER” indicator is illuminated.

The controller counts the number of spheres that have been processed and stores the information in two counters. The sphere count for the current operation is normally displayed on the segment LED display. The count goes to 9999 and then wraps to 0 and restarts. Pushing and holding the “RESET” toggle switch for *two seconds* resets the operation count to zero.



The lifetime count of spheres is displayed on the segment LED by pushing the “RESET” toggle switch *momentarily*. The lifetime count equals the number displayed multiplied by 1000. These counts are maintained in memory even when the unit is powered down.



The design of the control panel switches and indicators inhibits water ingress onto the circuit board. However, it does not provide a watertight enclosure and the panel is not intended to be immersed or to be sprayed with water.

### Tethered Remote Control

The tethered remote control is a hand-held device which allows the operator to control the feed gates, adjust the drop rate, and monitor the machine operation.

The green “PWR” indicator illuminates when the machine is receiving power from an external source.

The yellow “RUN” indicator illuminates when the hopper drive motor is operating. The indicator flashes when the shuttle drive motor is operating.

The red “FAULT” indicator flashes when the controller detects a jam occurring in the injection shuttle.

The “FEED GATE” switch is a three position momentary toggle that allows the operator to open or close the feed gates.

The seven-position “SPEED” control allows the operator to adjust the drop rate while the machine is in operation. The drop rates correspond to 25-175 spheres per minute in 25 spm increments.

The controller measures the shuttle drive motor speed and uses a PID algorithm to calculate how to adjust the drive motor power to ensure that the actual drop rate is equal to the selected drop rate.

The tethered remote control is attached to the front panel via a twist lock plug and a 4 ft. jacketed cable.



### Optional Components

A 110 VAC portable power supply providing 24VDC x 10A is available for bench testing the Red Dragon.

This power supply can also be used to charge the backup battery, if required.



*Optional portable power supply.*

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## Section 2: Operations

### Pilot and Operator Responsibilities

The occupants of the aircraft shall be limited to the pilot, the Red Dragon operator and the firing boss, if essential to the mission.

#### CAUTION

- It is mandatory that only adequately trained personnel operate the Red Dragon.
- A training manual is provided with the dispenser to be used as a guideline for operator training.
- Do not operate the dispenser without a full understanding of all operational and safety aspects of the Red Dragon as contained within this manual.
- Care should be taken to prevent the contamination of streams and lakes.

#### *Pilot Duties and Responsibilities*

The pilot-in-command is responsible for all matters related to aircraft operations and safety, including installation and operation of the Red Dragon in the helicopter.

The pilot-in-command must be totally familiar with the system and its operation. The pilot shall have approval for aerial ignition operations and receive a briefing on the operational objectives as well as ground and flight procedures.

In addition to the familiarization received during the pre-flight test, the pilot must be provided with specific instructions regarding destination, objective and general procedures.

The maximum recommended groundspeed for Red Dragon operation is 50 m.p.h. (45 knots).

The recommended operational height is 300 ft (100 m) above ground level.



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### ***Operator Duties and Responsibilities***

The operator is responsible for the preparation, operation, maintenance and care of the Red Dragon dispenser. The machine operator must have experience with fire behaviour, be mechanically inclined and have the ability to handle several responsibilities (mental and physical) simultaneously. The operator must have successfully completed training courses in both dispenser operation and in helicopter safety. The operator must:

- Determine if the prescribed spacing of ignition is occurring and make any necessary adjustments.
- Determine if any malfunction occurs and act accordingly.
- In the event of a fire within the Red Dragon, determine if the fire has or can be extinguished or if the unit must be jettisoned.
- Communicate with the pilot on all procedures associated with the burning operation and on any flight emergencies that may occur during the burn mission.
- Jettison the hopper, if required.

## **Pre-Flight Procedures**

### ***Bench Testing***

Bench testing shall be performed prior to each burn operation. The purpose of the bench test is to ensure satisfactory ignition of the Dragon Eggs. The Red Dragon does not require the operator to test and calibrate the quantity of glycol entering the spheres.

#### **CAUTION**

This is a “live” test – ignition will occur during this test.

Do not conduct tests in or near areas where combustible sources can be ignited (e.g. do not test near a fuel source).

An emergency water supply must be available in close proximity.

A fire extinguisher with a minimum 20 BC rating should be available in close proximity.

- Remove the base and hopper assembly and set aside.
- Remove the Red Dragon mainframe, close the crate and place the mainframe on top of the crate.



- Connect the bench test power cord to the Red Dragon dispenser.
- Connect the other end of the power cord to the optional 28VDC power supply or to two 12VDC batteries wired in series to produce 24VDC.

**CAUTION**

Ensure potassium permanganate does not come into contact with battery acid!

- Ensure glycol and water drain valves are closed.



- Fill the emergency water storage tank. A safety interlock, indicated by a light on the main body control panel, will inhibit system operation if the water tank is not sufficiently filled with water.



- Fill the glycol tank with undiluted and unused ethylene glycol (anti-freeze).



- Remove the two pump assemblies from the injection head by loosening the captive screws in the side panel.



- Prime each pump assembly by squeezing and releasing the pump arm until glycol squirts from the injection needle.



- Replace the pump assemblies.

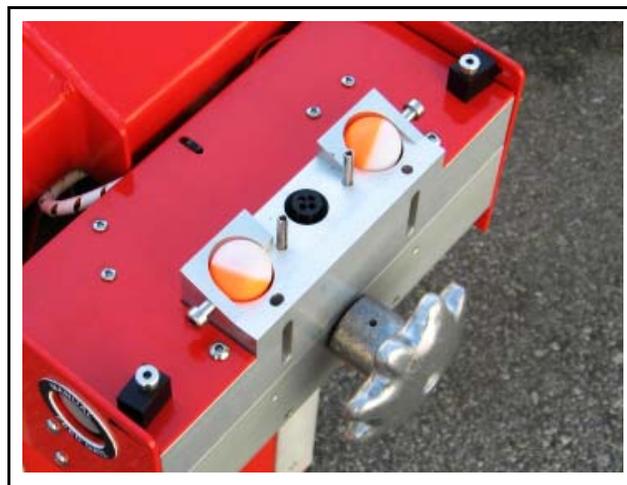
- Place an open-top metal container under the injection head outlet.



**CAUTION**

Do not put water in metal container!

- Place two spheres into each of the cavities of the gate assembly.



- Attach the tethered remote control to the control panel on the main body.

- Press the main circuit breaker on the front panel to the reset position.
  - The “POWER” indicator on the main control panel will illuminate.



- Switch the “RUN/STOP” switch on the main control panel to “RUN”.



- Set the “SPEED” switch on the tethered remote control to “1.”



- Press and release the “FEED GATE” switch on the tethered remote control to the “OPEN” position.
  - The feed gates will open.
  - The shuttle drive motor will start.
  - The spheres will be injected and fall out of the injection head outlet.
- When the second sphere exits the machine, begin timing the ignition delay.
  - The injected spheres should ignite within 25-30 seconds depending on temperature. Only three of the four spheres will ignite as the first sphere is not injected.
- Press the “FEED GATE” switch on the tethered remote control to “CLOSE.”
- Switch the “RUN/STOP” switch on the main control panel to “STOP.”

### ***Dispenser Installation***

#### **CAUTION**

The Red Dragon dispenser must be readied for installation outside the safety circle of the helicopter.

- Remove the Red Dragon system from its shipping container.



- Remove the hopper from the machine by grasping the hopper lock handle and pulling up.



- Ensure the glycol and water drain valves are closed.



- Check/fill the water storage tank. Secure the filler/breather cap.



- Check/fill the glycol tank with undiluted and unused ethylene glycol (anti-freeze). Secure the filler/breather cap.



- Remove the right rear door of helicopter.
- Remove all carpet and porous floor coverings.
- Clear the cabin of all loose articles.
- Use duct tape or other means to protect the paint finish around the door. Consult with the pilot before using.
- If the support base is required, position appropriately within the aircraft. If not required, store the base in the shipping container.

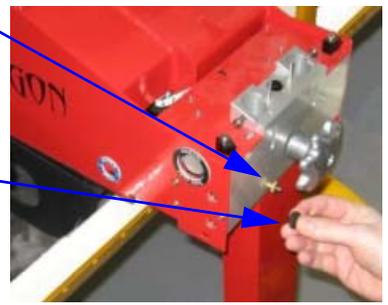


- Install the Red Dragon dispenser in the door opening of the aircraft so that the injection head protrudes past the door sill.



- Attach and secure the outlet chute, using a thumbnut and locking thumbnut on each screw.

**Note:** The gold nut must be located on the OUTSIDE of the injection head, followed by the black nut.



- Attach the Y strap by snapping the "Y" end to the holes on each side of the outboard end of the dispenser. Ensure that the strap goes inboard of the exit chute.



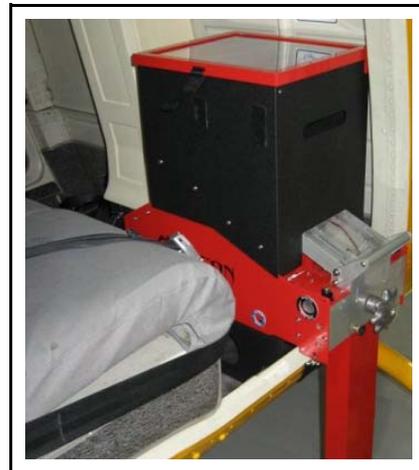
- Push the dispenser inboard until the main body fits snugly into the support base.



- Pass the free end of the strap beneath the belly of the aircraft and in under the opposite door. Check that the strap is not twisted or obstructing any aircraft vents, antennae or release cables. Feed the free end up and over the roller on the quick release fitting attached to the other end of the dispenser. Pull the free end to tighten the strap.



- Replace the hopper assembly onto the dispenser. Slide the dispenser as far forward as possible to provide leg-room between the dispenser and the rear seat. Ensure that the hopper lid opens freely. Tighten the belly strap snugly.



- Attach the tethered remote control cable to the control panel receptacle on the main body.
- Check that the main breaker is in the tripped (out) position.
- Connect the power cable to the auxiliary power outlet in the helicopter. Connect the other end of the power cable to the connection on the Red Dragon dispenser.
- Reset the main circuit breaker by pushing it in. The “POWER” indicator on the main control panel should illuminate. If the breaker trips immediately, this indicates that the power supply needs to have its polarity reversed.

### ***Pre-Flight Check***

The pre-flight check should be performed daily, prior to intended use. The purpose of this check is to confirm the readiness of the dispenser and support equipment.

- Press the main circuit breaker on the front panel to the reset position.
  - The “POWER” indicator on the main control panel should illuminate.
  - The “PWR” indicator on the tethered remote control should illuminate.
  - The “LOW WATER” indicator on the main control panel should not illuminate
- Switch the “RUN/STOP” switch on the main control panel to “RUN”.
  - The hopper agitator motor should start.
  - The indicator above the switch on the main control panel should illuminate.
  - The “RUN” indicator on the tethered remote control should illuminate.
- Press the “FEED GATE” switch on the tethered remote control to the “OPEN” position. Switch activates immediately and does not need to be held.
  - The feed gates should open and the shuttle drive motor should start.
  - The “RUN” indicator on the tethered remote control should flash.
  - The LED display on the main control panel should start counting spheres.
- Adjust the “SPEED” control on the tethered remote control from "1" to "7."
  - The shuttle drive motor should speed up.



- Press the “FEED GATE” switch on the tethered remote control to the “CLOSE” position. Switch activates immediately and does not need to be held.
  - The feed gates should close and the shuttle drive motor should run for a few seconds and then stop.
  - Once the shuttle drive motor has stopped, the “RUN” indicator on the tethered remote control should stop flashing and display a steady yellow light.
  - The LED display on the main control panel should stop counting spheres.
- Press the “COUNT” switch on the main control panel to the “RESET” position. HOLD the switch for a minimum of two seconds.
  - The sphere count on the LED display should reset to zero.
- Switch the “RUN/STOP” switch on the main control panel to “STOP.”
  - The indicator above the switch on the main control panel should extinguish.
  - The hopper agitator motor should stop.
- Press and hold the “WATER” switch on the main control panel to the “ON” position.
  - The water pump should start and inject water into both injection chambers.
  - The indicator above the switch on the main control panel should illuminate.
- Fill the hopper with Dragon Eggs. Close and secure the lid.
- Check that any additional Dragon Eggs carried within the cabin area are properly contained and secured.
- Check the system for leaks.
- Check that additional one gallon container of water is available.
- Check that a sharp knife is within reach of the operator.
- Check intercom and ground to air communications.

**CAUTION**

Extra ethylene glycol (antifreeze) shall not be carried in the same compartment as Dragon Eggs. Lead acid batteries shall not be carried in the cabin to power the Red Dragon.

## In-Flight Procedures

### Dry Run Procedure

- Pilot should make a dry run over the burn area to ensure communications between all parties involved and to determine boundaries of the burn area.
- After the dry run over the planned area, the pilot and operator should determine the firing pattern as instructed by the burn boss or fire boss.
- The fire boss should consult the following chart to determine the drop rate for varying spacing and aircraft speeds.

### Dragon Egg Ground Spacing

		Aircraft Ground Speed (mph)										
		10	15	20	25	30	35	40	45	50	55	60
Selected Drop Rate	1	35 ft	53 ft	70 ft	88 ft	106 ft	123 ft	141 ft	158 ft	176 ft	197 ft	211 ft
	2	18 ft	26 ft	35 ft	44 ft	53 ft	62 ft	70 ft	79 ft	88 ft	97 ft	106 ft
	3	12 ft	18 ft	23 ft	29 ft	35 ft	41 ft	47 ft	53 ft	59 ft	65 ft	70 ft
	4	9 ft	13 ft	18 ft	22 ft	26 ft	31 ft	35 ft	40 ft	44 ft	48 ft	53 ft
	5	7 ft	11 ft	14 ft	18 ft	21 ft	25 ft	28 ft	32 ft	35 ft	39 ft	42 ft
	6	6 ft	9 ft	12 ft	15 ft	18 ft	21 ft	23 ft	26 ft	29 ft	32 ft	35 ft
	7	5 ft	8 ft	10 ft	13 ft	15 ft	18 ft	20 ft	23 ft	25 ft	28 ft	30 ft

***Dispensing Dragon Eggs***

- 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.
- Ensure a steady progression of spheres exiting the hopper.
- The feed rate can be adjusted at any time during the operation.
- As required, the feed gate toggle can be set to either "OPEN" or "CLOSE" to start or stop the flow of spheres through the machine.
- 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.
- Follow the procedures for an emergency situation as described in section 3 *Emergency Procedures*.

***Dispenser Shut-Down***

- Do not exit the burn area until all operations have ceased.
- Ensure that the feed gates are closed.
- Toggle the "RUN/STOP" switch to "STOP."
- Ensure that no spheres remain in the injection head.
- The aircraft may then leave burn area.
- Clean the unit according to daily maintenance directions in section 6 *Maintenance and Service*.

***System Fault Status***

For troubleshooting information, see section 4 *Troubleshooting*. Emergency repairs or system clean-out can be done by the operator at a convenient landing spot, using the troubleshooting guide, if the required tools/spare parts are available.

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## Section 3: Emergency Procedures

### Equipment Malfunctions

The Red Dragon dispenser has been designed to maximize safety under normal operating conditions. By following the correct procedures, as outlined within this manual, the system will provide a consistent supply of Dragon Eggs to the target within minimal interruption. However, equipment malfunctions can still occur and, due to the nature of the operation, safety must remain paramount. Interruption of operation caused by a jammed sphere or a power failure will result in a primed sphere remaining within the injection head. Spheres remaining within the head may be primed with glycol and will auto-ignite within the head.

#### *Jammed Sphere*

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

- “FAULT” indicator on the tethered remote control flashes.
- “MOTOR FAULT” indicator on the main control panel illuminates.
- Manual hand-wheel stops rotation when the feed gates are open and machine has power.
- Flow of spheres into the gate block stops when the feed gates are open and machine has power.

If a sphere jam occurs in the machine, take the following immediate actions:

- If automatic clearing fails, notify the pilot of the situation.
- Press the manual feed control knob to close and lock the feed gates.
- Rotate the manual hand wheel in the reverse and forward directions to clear the jam.
- If jam clears, notify the pilot that burning can recommence.
- Toggle the feed gate switch to the “OPEN” position to reopen feed gates.

#### **CAUTION**

If the hopper is removed during operations, the top two spheres in the gate assembly must be retrieved before re-attaching the hopper. Failure to do so may prevent opening of the gates.

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.
- Clean the ignition head as detailed in section 6 *Maintenance and Cleaning*.

**WARNING**

If a fire continues or re-ignites, land immediately.

### **Power Failure**

Power failure to the Red Dragon machine can be caused by the following conditions:

- Tripping of the main circuit breaker.
- Accidental disconnection of the power cord.
- Tripping of the aircraft circuit breaker.
- General aircraft power system failure.

The operator is alerted to a power failure by any of the following conditions:

- All indicators on the tethered remote control and main control panel are extinguished.
- Manual hand-wheel stops rotating when the feed gates are open.
- Flow of spheres into the gate block stops when the feed gates are open.

If a power failure occurs, take the following immediate actions:

- Notify the pilot of the situation.
- Press the manual feed control knob to close and lock the feed gates.
- Rotate the manual hand-wheel three full turns to clear any remaining spheres in the ignition head.
- Investigate the cause of the power failure.



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## Aircraft Emergency

In the event of an aircraft emergency, the pilot may direct the operator to jettison part or all of the Red Dragon dispenser to remove the primary fuel and oxidizer sources from the aircraft.

### CAUTION

Request permission from the pilot before jettisoning any equipment. Look for a suitable location to jettison, making every attempt to avoid dropping equipment over a developed area.

### *Hopper Jettison*

To jettison the hopper, take the following immediate actions:

- Receive direction from pilot to jettison the hopper.
- Close and secure the hopper lid.
- Grasp the hopper and lift clear of the dispenser.
- Jettison the hopper through the door opening making sure to clear the aircraft structure.

### *Machine Jettison*

If absolutely required, the remaining pieces of the Red Dragon can also be jettisoned from the aircraft.

To jettison the machine, take the following immediate actions:

- Receive direction from pilot to jettison the machine.
- Grasp the power cord on each side of the connection, twist and pull apart.
- Cut the Y strap with the cutter provided.
- Lift the main body of the machine clear of the support base and jettison through the door opening making sure to clear the aircraft structure.
- Jettison the support base through the door opening making sure to clear the aircraft structure.
- Jettison any remaining Dragon Eggs and debris.



## Safety Considerations

### *Dragon Eggs*

Although stable, prior to priming with ethylene glycol, the material within the sealed Dragon Egg is classified as a hazardous substance and, as such, must be handled and transported in the correct manner. Potassium permanganate ( $\text{KMnO}_4$ ) is a strong oxidizer and will react violently with certain chemicals as indicated in the following table.

#### **WARNING**

There are dangerous compounds that must be isolated from the potassium permanganate in Dragon Eggs during shipping and storage. These compounds include:

Antimony	Aluminium Carbide
Arsenic	Ethylene Glycol
Glycerol	Hydrogen Trisulphide
Hydrogen Peroxide	Phosphorous
Sulphur	Sulphuric Acid
Titanium	

In addition, potassium permanganate should not be inhaled or otherwise absorbed or come in contact with the skin. A full MSDS sheet for the chemical is included in the appendix.

## Section 4: Troubleshooting

This section describes remedial actions to problems that are encountered during the pre-flight bench testing and pre-flight check (see section 2 *Operations, Pre-Flight Procedures*). The actions are limited to those which can be performed in the field by an operator with limited tools. For more advanced trouble-shooting, consult the Red Dragon Service manual.

Problems occurring during flight are covered in section 3 *Emergency Procedures, Equipment Malfunctions*.

### Hopper Agitator Non-Operational

<b>No Power</b>	“POWER” indicator not illuminated	<p>Check that the aircraft’s auxiliary circuit breaker is not tripped.</p> <p>Check that the power cord is properly attached to the aircraft auxiliary outlet.</p> <p>Check that the power cord is properly attached to the pigtail cable of the dispenser.</p> <p>Check that the dispenser’s main circuit breaker is not tripped.</p>
<b>Low Water Interlock</b>	“LOW WATER” indicator illuminated	<p>Check water level in tank. Add water as required.</p> <p>Check water drain valve is closed.</p>
<b>Switch Setting</b>	“RUN” indicator not illuminated	Check that the “RUN / STOP” switch is in “RUN” position.
<b>Hopper Connection</b>	“RUN” indicator illuminated	Check that the hopper is seated correctly on gate assembly.
<b>Agitator Linkage</b>	“RUN” indicator illuminated	<p>Toggle the “RUN / STOP” switch to the “STOP” position and wait for the hand wheel to stop rotating.</p> <p>Remove the hopper from the gate assembly.</p> <p>Check that the hopper agitator mechanism is not jammed.</p> <p>Check that the hopper agitator linkages are correctly attached.</p>

## Shuttle Drive Non-Operational

<b>No Power</b>	“POWER” indicator not illuminated	<p>Check that the aircraft’s auxiliary circuit breaker is not tripped.</p> <p>Check that the power cord is properly attached to the aircraft auxiliary outlet.</p> <p>Check that the power cord is properly attached to the pigtail cable of the dispenser.</p> <p>Check that the dispenser’s main circuit breaker is not tripped.</p>
<b>Low Water Interlock</b>	“LOW WATER” indicator illuminated	<p>Check water level in tank. Add water as required.</p> <p>Check water drain valve is closed.</p>
<b>Switch Setting</b>	“RUN” indicator not illuminated	Check that the “RUN / STOP” switch is in “RUN” position.
<b>System Delay</b>	“RUN” indicator steady illumination	<p>Wait for two seconds after “RUN / STOP” has been switched to the “RUN” position.</p> <p>Toggle the “FEED GATE” switch to the “OPEN” position.</p>
<b>Tether Connection</b>	“RUN” indicator steady illumination	<p>Check that the tethered remote control is properly plugged into the receptacle on the front panel.</p> <p>Toggle the “FEED GATE” switch to the “OPEN” position.</p>
<b>Jammed Sphere</b>	“MOTOR FAULT” indicator illuminated	<p>Switch the “RUN / STOP” switch to the “STOP” position.</p> <p>Pull the main circuit breaker.</p> <p>Remove the hopper.</p> <p>Unlock the gate assembly and remove.</p> <p>Examine shuttle cavities and remove jammed and/or broken spheres. Rotate manual hand wheel as required. Blow out with compressed air if available.</p> <p>Replace gate assembly and hopper.</p> <p>Reset the main circuit breaker.</p>

## Feed Gates Won't Open

<b>No Power</b>	"POWER" indicator not illuminated	<p>Check that the aircraft's auxiliary circuit breaker is not tripped.</p> <p>Check that the power cord is properly attached to the aircraft auxiliary outlet.</p> <p>Check that the power cord is properly attached to the pigtail cable of the dispenser.</p> <p>Check that the dispenser's main circuit breaker is not tripped.</p>
<b>Low Water Interlock</b>	"LOW WATER" indicator illuminated	<p>Check water level in tank. Add water as required.</p> <p>Check water drain valve is closed.</p>
<b>Switch Setting</b>	"RUN" indicator not illuminated	Check that the "RUN / STOP" switch is in "RUN" position.
<b>System Delay</b>	"RUN" indicator steady illumination	<p>Wait for two seconds after "RUN / STOP" has been switched to the "RUN" position.</p> <p>Toggle the "FEED GATE" switch to the "OPEN" position.</p>
<b>Tether Connection</b>	"RUN" indicator steady illumination	<p>Check that the tethered remote control is properly plugged into the receptacle on the front panel.</p> <p>Toggle the "FEED GATE" switch to the "OPEN" position.</p>
<b>Jammed Feed Gates</b>	"RUN" indicator flashing	<p>Switch the "RUN / STOP" switch to the "STOP" position and wait for the hand wheel to stop rotating.</p> <p>Remove the hopper.</p> <p>Unlock the gate assembly and remove.</p> <p>Check the sphere path in the gate assembly for obstructions preventing the gates from opening.</p> <p>Switch the "RUN / STOP" switch to the "RUN" position and wait until the shuttle drive motor starts.</p> <p>Toggle the "FEED GATE" switch between the "OPEN" and "CLOSE" positions and check for movement of the feed gates.</p>

## Drop Rate Not Changing

<b>Tether Connection</b>		Check that the tethered remote control is properly plugged into the receptacle on the front panel.
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## No Emergency Water

<b>Water Tank Empty</b>	“LOW WATER” indicator illuminated	Check water level in tank. Add water as required. Check water drain valve is closed.
<b>No Power</b>	“POWER” indicator not illuminated	Check that the aircraft’s auxiliary circuit breaker is not tripped. Check that the power cord is properly attached to the aircraft auxiliary outlet. Check that the power cord is properly attached to the pigtail cable of the dispenser. Check that the dispenser’s main circuit breaker is not tripped.
<b>Battery Discharged</b>	“bAtt” indicated on LED display	Recharge backup battery.

## Dragon Eggs Not Igniting

<b>Glycol Tank Empty</b>		Check glycol level in tank. Add glycol as required. Check glycol drain valve is closed. Remove pump assemblies from injection head. Depress and release pump arms repeatedly until glycol flows from injection needles.
<b>Air in Glycol System</b>		Remove pump assemblies from injection head. Depress and release pump arms repeatedly until glycol flows from injection needles.
<b>Plugged Needle</b>		Remove pump assemblies from injection head. Check that injection needles are not plugged. Clean as required.

## Main Circuit Breaker Trips

<b>Reverse Polarity</b>		Check the polarity of the power supply.
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## Section 5: Specifications

### Dispenser Specifications

#### **Performance**

Number of speeds	7
Min. drop rate	25 spheres per min.
Max. drop rate	175 spheres per min.
Hopper capacity	650 spheres

#### **Power**

Voltage	24-32 VDC
Connector	MS3116F-12-3P (Pin A +28V, Pin B GND)
Main circuit breaker	5A, MS3320, manual reset

#### **Operational Weight**

Red Dragon dispenser, tanks empty	48.0 lbs	21.8 kg
Ethylene glycol	7.9 lbs	3.6 kg
Water supply for emergency use	4.1 lbs	1.9 kg
Dragon Eggs – (650 spheres)	<u>6.8 lbs</u>	<u>3.1 kg</u>
<b>Total operational weight</b>	<b>66.8 lbs</b>	<b>30.4 kg</b>



**Dispenser Dimensions**

Length	24.50 in	62.4 cm
Width	10.75 in	27.3 cm
Height		
With support base	24.00 in	61.0 cm
Without support base	19.00 in	48.3 cm

**Fluid Volumes**

Glycol tank	0.8 US gal	3.2 liter
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(A full glycol tank will inject approximately 5,000 Dragon Egg spheres.)

Water tank		
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Full	0.5 US gal	1.9 liter
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Minimum required	0.2 US gal	0.8 liter
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**Shipping Crate Dimensions**

Length	31 in	79 cm
Width	13 in	33 cm
Height	24 in	61 cm

**Shipping Weight**

Red Dragon dispenser, tanks empty	48 lbs	22 kg
Shipping container	44 lbs	20 kg
Miscellaneous	<u>2 lbs</u>	<u>1 kg</u>
<b>Total shipping weight</b>	<b>94 lbs</b>	<b>43 kg</b>



## Dragon Egg Specifications

### Weights

<i>Individual Dragon Egg</i>	.17 oz	4.8 g
<i>Box of 1,000 Dragon Eggs</i>		
Potassium permanganate (KMnO <sub>4</sub> )	6.6 lbs	3.0 kg
High-impact polystyrene (HIPS) shells	4.0 lbs	1.8 kg
Packaging material	<u>1.5 lbs</u>	<u>0.7 kg</u>
Gross weight	12.1 lbs	5.5 kg

### Dimensions

<i>Individual Dragon Egg</i>	1.0 in	26.0 mm
<i>Box of 1,000 Dragon Eggs</i>		
Length	16.0 in	40.6 cm
Width	9.0 in	22.9 cm
Height	10.3 in	26.1 cm

### Ignition Parameters

Injection to the first combustion (smoke)	25 seconds @ 55° F (13° C)
Injection to full combustion (flame)	35 seconds @ 55° F (13° C)
Total useful combustion time	80 seconds @ 55° F (13° C)

#### Important Note

Increasing ambient temperatures will decrease the ignition delay time.

### Safety

Although stable, prior to priming with ethylene glycol, the material within the sealed Dragon Egg is classified as a hazardous substance and, as such, must be handled and transported in the correct manner. Potassium permanganate ( $\text{KMnO}_4$ ) is a strong oxidizer and will react violently with certain chemicals as indicated below. In addition, potassium permanganate should not be inhaled or otherwise absorbed or come in contact with the skin.

#### WARNING

There are dangerous compounds that must be isolated from the potassium permanganate in Dragon Eggs during shipping and storage. These compounds include:

Antimony	Aluminium Carbide
Arsenic	Ethylene Glycol
Glycerol	Hydrogen Trisulphide
Hydrogen Peroxide	Phosphorous
Sulphur	Sulphuric Acid
Titanium	

A full MSDS sheet for the chemical is included in the appendix.

### Dragon Egg Shipping Box Certifications

- The complete package has been tested to meet the requirements of ISTA procedure 1A.
- The complete package has been tested to meet the requirements of UN 4G combination packaging.

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## Section 6: Maintenance and Service

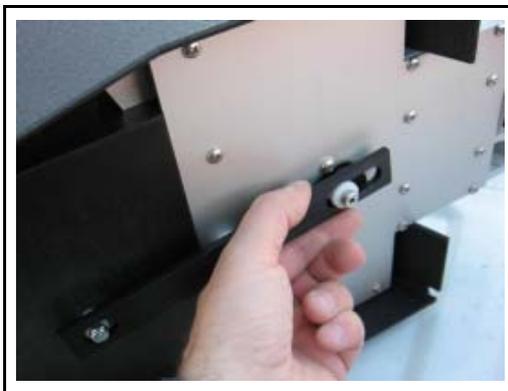
### Cleaning and Storage

This section provides an overview of service and maintenance that can be performed in the field. The accompanying service manual provides a more extensive review.

#### *Cleaning*

This cleaning procedure shall be performed immediately following burn operations. Delay in cleaning the unit will result in the hardening of any remaining chemical in the injection head.

- Remove the Red Dragon dispenser from the aircraft.
- Wipe down the aircraft floor.
- Remove any protective tape that was installed on the aircraft door sill or fuselage.
  
- Remove the hopper.
  - Empty any remaining Dragon Eggs into an appropriate container.
  - Wipe down the inner surfaces of the hopper to remove any potassium permanganate dust.
  - Check the agitator and linkages for signs of excessive wear.



- Drain the glycol tank.
  - Insert 8 mm drain tubing into the glycol drain valve and place the other end into a suitable container.
  - Open drain valve by rotating with a slotted screwdriver so that the slot is vertical.
  - After draining, close the drain valve and remove tubing.



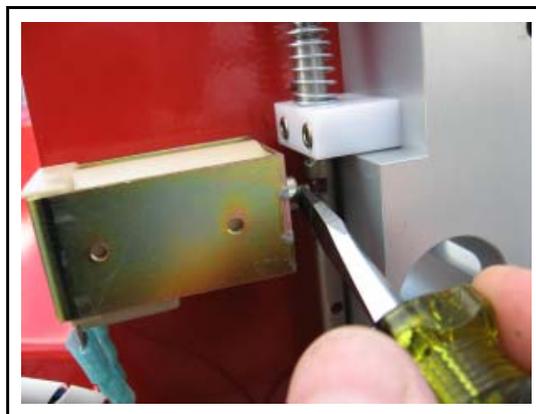
- Drain the water tank.
  - Insert 8 mm drain tubing into the water drain valve and place the other end into a suitable container.
  - Open drain valve by rotating with a slotted screwdriver so that the slot is vertical.
  - After draining, close the drain valve and remove tubing.



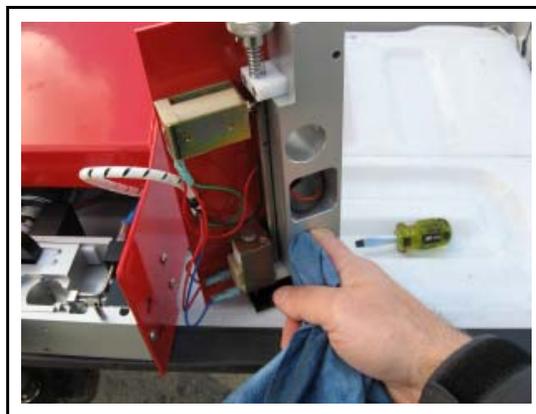
- Remove the feed gate assembly.



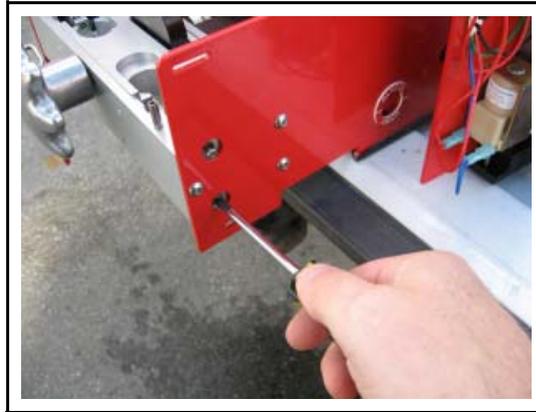
- Unlock the feed gate control rod by lifting up on the open solenoid plunger with a slotted screwdriver. The feed gate control rod should spring open.



- Clean the sphere paths in the gate assembly using a cloth and a citrus-based cleaner/degreaser such as Simple Green all purpose cleaner.



- Remove the glycol pump assemblies by loosening captive screws.



- Clean needle bore with the tool provided.
- Clean outside of needle with Scotch-Brite pad provided.
- Check the sharpness of the needle. If required, sharpen with the small file provided.
- Check pump operation by squeezing the pump arm and ensuring a squirt of glycol from the injection needle.



- Clean the injection shuttle and injection block.

**CAUTION**

Wear latex gloves and eye protection when cleaning the unit with water or when cleaning the unit with compressed air. When mixed with water, potassium permanganate will form a dark purple liquid that will cause staining to metals and skin.

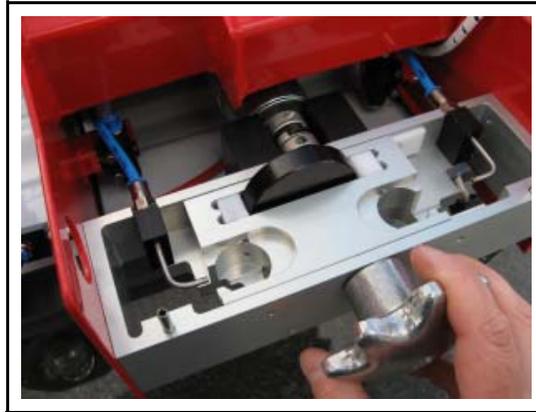
- Loosen any potassium permanganate and polystyrene plastic residue from the shuttle and injection block using the wire brush provided. If available, used compressed air to blow out the residue.



- Clean the injection head and shuttle using a cloth and a citrus-based cleaner/degreaser such as Simple Green all purpose cleaner. If an appropriate cleaner is not available, water can be used (with caution).



- Rotate the hand wheel to check the drive system for smooth operation.



- Check the shuttle guides for excessive wear.
- Check the cam guides in the injection shuttle for excessive wear.

#### **Important Note**

Do not lubricate the contact points between the injection shell, drive cam and injection block. These contact surfaces have an aluminium/polyacetal interface which is self-lubricating. The use of products such as Tri-Flo, WD-40 or light machine oil will cause dirt and permanganate residue to accumulate and may cause mechanical seizure.

- Replace the pump assemblies.
- Replace the feed gate assembly.
- Wipe down the remaining accessible surfaces on the machine.

### Storage

Proper packing of the Red Dragon will ensure that no damage occurs to the unit during shipping or long term storage.

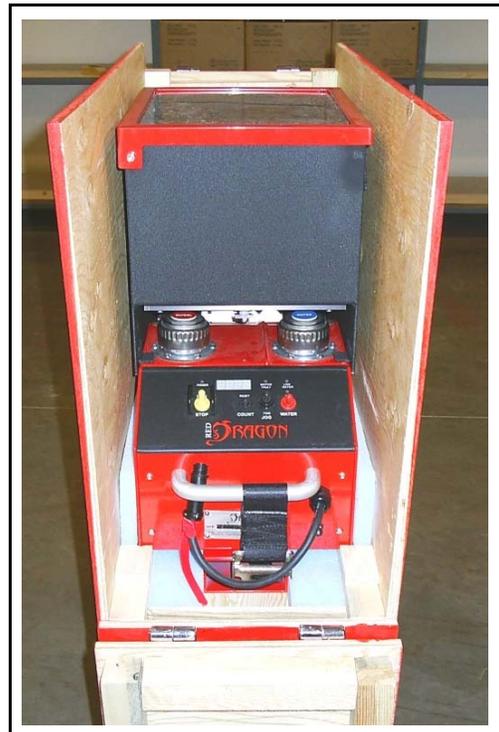
- Dry machine before re-packing in shipping crate.
- Remove the tethered remote control and place in the hopper.
- Remove the power cord and place in the hopper.
- Place mounting strap in the hopper.
- Place the bench test power cord in the hopper.
- Place the tool kit in the hopper.
- Remove the outlet chute and place in the bottom of the crate.



- Place the main body of the dispenser into the crate with the control panel facing the open end of the crate.



- Replace the hopper on the dispenser.



- Place the support base in the crate between the hopper and the open end above the control panel.



- Replace the crate lid and latch the crate.
- Store the shipping crate in a dry location.

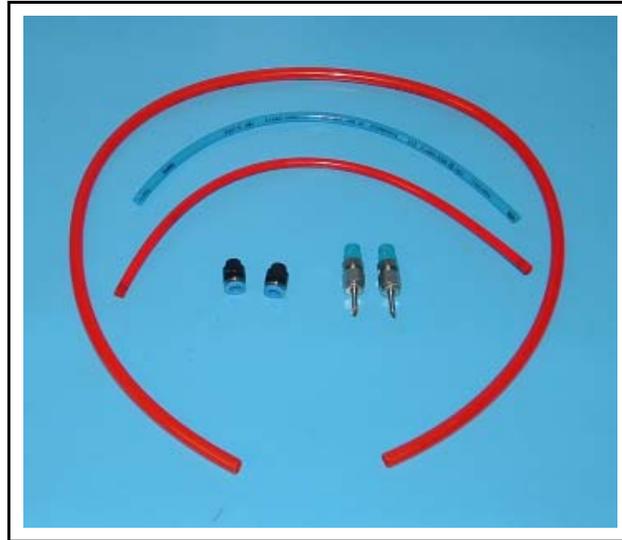
## Red Dragon Tool Kit



A field service tool kit is provided consisting of:

- slotted screwdriver for operating drain valves
- #1 Philips screwdriver for removing glycol pump assemblies
- two 7/16" open end wrenches for removing injection needles
- needle nose pliers
- 1/8" hex key wrench
- 2.5 mm hex key wrench
- sharpening stone for needle touch-up
- tip cleaner set for cleaning needle bore
- Scotch-Brite abrasive pad for cleaning moving parts
- small metal bristle brush

## Spare Parts



The following spare parts are include in the tool kit:

- two injection needles
- 6 mm X 12" blue tubing
- 6 mm X 12-1/2" red tubing
- 8 mm X 32" red tubing
- two 6 mm tube caps

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## Section 7: Testing

### Bench Testing

Bench testing shall be performed prior to each burn operation. The purpose of the bench test is to ensure satisfactory ignition of the Dragon Eggs. The Red Dragon does not require the operator to test and calibrate the quantity of glycol entering the spheres.

#### CAUTION

- This is a “live” test – ignition will occur during this test.
- Do not conduct tests in or near areas where combustible sources can be ignited (e.g. do not test near a fuel source).
- An emergency water supply must be available in close proximity.
- A fire extinguisher with a minimum 20 BC rating should be available in close proximity.

- Remove the Red Dragon system from its shipping container.
- Remove the hopper, with lid, and set aside – this is not required for this test.
- Lift the main body clear of the support base – the support base is not required for this test.
- Mount the Red Dragon securely on a suitable table or bench.
- Connect the bench test power cord to the Red Dragon dispenser.
- Connect the other end of the power cord to the optional 28VDC power supply, or to two x 12VDC batteries wired in series to produce 24VDC.

#### CAUTION

Ensure Potassium Permanganate does not come into contact with battery acid!

- Ensure glycol and water drain valves are closed.
- Check/fill the emergency water storage tank. Secure filler cap. A safety interlock - indicated by a light on the main body control panel - will inhibit system operation if the water tank is not sufficiently filled with water.



- Check/fill the glycol tank with undiluted and unused ethylene glycol (anti-freeze). Secure filler cap.
- Remove the two pump assemblies from the injection head by loosening the captive screws in the side panel.
- Prime each pump assembly by squeezing and releasing the pump arm until glycol squirts from the injection needle.
- Replace the pump assemblies.
- Attach the outlet chute.
- Attach the tethered remote control to the control panel on the main body.
- Place an open-top metal container under the exit chute.

**CAUTION**

Do not put water in metal container!

- Place two spheres into each of the cavities of the gate assembly.
- Press the main circuit breaker on the front panel to the reset position.
  - The “POWER” indicator on the main control panel will illuminate.
- Switch the “RUN/STOP” switch on the main control panel to “RUN”.
- Set the “SPEED” switch on the tethered remote control to “1.”
- Press and release the “FEED GATE” switch on the tethered remote control to the “OPEN” position.
  - The feed gates will open.
  - The shuttle drive motor will start.
  - The spheres will be injected and fall out of the exit chute.
- When the second sphere exits the machine, begin timing the ignition delay.
- When the fourth sphere exits the machine, press the “FEED GATE” switch on the tethered remote control to “CLOSE”
  - The shuttle drive motor will run for three revolutions and then stop.
  - The injected spheres should ignite within 25-30 seconds depending on temperature. Only three of the four spheres will ignite as the first sphere was not injected.
- Switch the “RUN/STOP” switch on the main control panel to “STOP.”

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## Hangfire Test Procedure

A hangfire test shall be performed annually at the start of the burning season. The purpose of the hangfire test is to ensure that the emergency fire suppression system is capable of extinguishing a fire in the injection head.

### CAUTION

- This is a “live” test – ignition will occur during this test.
- Do not conduct tests in or near areas where combustible sources can be ignited (e.g. do not test near a fuel source).
- An emergency water supply must be available in close proximity.
- A fire extinguisher with a minimum 20 BC rating should be available in close proximity.

- Remove the hopper and set aside – it is not required for this test.
- Mount the Red Dragon securely on a suitable table or bench.
- Connect the bench test power cord to the Red Dragon dispenser.
- Connect the other end of the power cord to a 24-28 VDC external power supply.

### CAUTION

Ensure Potassium Permanganate does not come into contact with battery acid!

- Ensure glycol and water drain valves are closed.
- Check/fill glycol tank.
- Check/fill emergency water tank.

### CAUTION

Do not operate water pump dry.

- Remove the glycol pump assemblies from the injection head by loosening the captive screws in the side panel.



- Prime each pump assembly by squeezing and releasing its pump arm until glycol squirts from the injection needle.
- Replace the pump assemblies.
- Attach the outlet chute.
- Place an open-top metal container under the exit chute.
- Attach the tethered remote control.
- Press the main circuit breaker on the front panel to the reset position.
  - The “POWER” indicator on the main control panel will illuminate.
- Switch the “RUN/STOP” switch on the main control panel to “RUN”.
- Press and release the “FEED GATE” switch on the tethered remote control to the “OPEN” position.
  - The feed gates will open.
  - The shuttle drive motor will start.
- Pull the main circuit breaker out to remove external power from the dispenser.
  - The shuttle drive motor will stop.
  - The feed gates will remain open.
- Switch the “RUN/STOP” switch on the main control panel to “STOP.”
- Rotate the hand wheel until the shuttle cavities align with the sphere paths in the feed gate assembly.
- Insert a Dragon Egg into each of the sphere paths in the feed gate assembly.
- Rotate the hand wheel one half turn and stop.
  - One Dragon Egg will fall out the outlet chute unprimed.
  - The second Dragon Egg will remain in the injection head and will auto-ignite after approximately 30 seconds.
- When smoke appears, press and hold the “WATER” switch on the main control panel for 10 seconds.
  - The indicator on the main control panel above the “WATER” switch will illuminate.
  - The water pump will discharge water through its nozzles into the injection chamber.
  - The fire will be extinguished.
- When the fire has been extinguished, clean the dispenser in accordance with section 6 *Maintenance and Service, Cleaning and Storage*.

	<h1>CAIROX<sup>®</sup> Potassium Permanganate</h1> <p>EC- SAFETY DATA SHEET is prepared according to the latest adaptations to (CLP) Regulations (EC) No 1272/2008 and (EC) No 1907/2006.</p> <p style="text-align: right;"><b>Material Safety Data Sheet</b> Page 1 of 11</p>	
	<p>This product is distributed by Canada Colors and Chemicals Limited General Inquiry: (905) 459-1232 24 Hour Emergency: (416) 444-2112 CCC: Product Code: <b>754506</b> CCC: Product Name: POT. PERMANGANATE BP GRADE</p> <p style="text-align: center;"></p>	
<b>MSDS # CP-103</b>	<b>Revision Date: November 2010</b>	<b>Supersedes: August 2010</b>

## Section 1 Identification of the Substance/Preparation and of the Company/Undertaking

<b>SUBSTANCE/PREPARATION NAME:</b> Potassium permanganate, KMnO <sub>4</sub> <b>PRODUCT NAME:</b> CAIROX <sup>®</sup> Potassium Permanganate <b>TRADE NAME:</b> CAIROX <sup>®</sup> Potassium Permanganate <b>SYNONYMS:</b> Permanganic acid potassium salt, Chameleon mineral, Condy's crystal, Permanganate of potash	
<b>USES OF SUBSTANCE:</b> Potassium Permanganate is an oxidant recommended for applications that require a strong oxidant.	
<b>COMPANY NAME (Europe):</b> CARUS EUROPE	<b>COMPANY ADDRESS:</b> C/ Secundino Roces, 3-Planta 1 <sup>a</sup> – Oficina 14, 33428 Cayes – Llanera, Asturias - Spain  <b>INFORMATION:</b> + (34) 985-785-513 <b>EMERGENCY TELEPHONE:</b> + (34) 985-785-513
<b>COMPANY NAME (US):</b> CARUS CORPORATION	<b>COMPANY ADDRESS:</b> 315 Fifth Street Peru, IL 61354, USA  <b>INFORMATION:</b> (815) 223-1500 (815) 224-6816 (FAX) <a href="http://www.caruscorporation.com">www.caruscorporation.com</a> (Web) <a href="mailto:salesmkt@caruscorporation.com">salesmkt@caruscorporation.com</a> (Email)  <b>EMERGENCY TELEPHONE:</b> (800) 435-6856 (USA) (815) 223-1500 (Other countries) (800) 424-9300 (CHEMTREC <sup>®</sup> , USA) (703) 527-3887 (CHEMTREC <sup>®</sup> , Other countries)

## Section 2 Hazards Identification

<b><u>GLOBAL HARMONIZED SYSTEM (GHS) OF CLASSIFICATION OF THE SUBSTANCE</u></b> Oxidizing solid, Category 2 Acute toxicity, Category 4 Aquatic toxicity (acute), Category 1 Aquatic toxicity (chronic), Category 1	
<b><u>GHS LABEL ELEMENTS, INCLUDING PRECAUTIONARY STATEMENTS</u></b> <b>Signal Word: DANGER</b> <b>Label Codes: GHS03, GHS07, GHS09</b> <b>Hazard Statements: H272, H302, H400, H410</b>	
  	
H272	May intensify fire, oxidizer
H302	Harmful, if swallowed
H410	Very toxic to aquatic life with long lasting effects
P210	Keep away from heat/sparks/open flames/hot surfaces. – No smoking
P220	Keep/Store away from clothing/combustible materials.
P260	Do not breathe dust
P280	Wear protective gloves/protective clothing/eye protection/face protection
P370 + P378	In case of fire: Use water for extinction
P501	Dispose of contents/container to appropriate places
P273	Avoid release to the environment.



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## Section 2 Hazards Identification (contd.)

### EU CLASSIFICATION

HAZARD SYMBOLS: O, Xn, N

RISK PHRASES: 8,22, 50/53

### HUMAN AND ENVIRONMENTAL HAZARDS

Contact with combustible material may cause fire.

Harmful if swallowed.

Very toxic to aquatic organisms may cause long-term adverse effects in the aquatic environment.

This substance is hazardous in the European Union according to the latest adaptations to Regulations (EC) No 1272/2008 and (EC) No 1907/2006.

### OTHER HAZARDS

#### EYE CONTACT

Potassium Permanganate is damaging to eye tissue on contact. It may cause burns that result in damage to the eye.

#### SKIN CONTACT

Momentary contact of solution at room temperature may be irritating to the skin, leaving brown stains. Prolonged contact is damaging to the skin. Concentrated solutions at elevated temperature and crystals are damaging to the skin.

#### INHALATION

Acute inhalation toxicity data are not available. However, airborne concentrations of potassium permanganate in the form of dust or mist may cause damage to the respiratory tract.

#### INGESTION

Potassium Permanganate, if swallowed, may cause burns to mucous membranes of the mouth, throat, esophagus, and stomach.

### HAZARDOUS MATERIALS IDENTIFICATION SYSTEM (HMIS) RATINGS

Health: 1 - Slight

Flammability: 0 - None

Reactivity: 0 - None

Personnel Protective Equipment: goggles face shield, apron, respirator and proper gloves.

## Section 3 Composition/Information on Ingredients

CAS#	Component / EC#	Percent	Symbols	Risks
7722-64-7	Potassium permanganate 231-760-3	>97.5	Xn N O	8,22, 50/53

### Component Related Regulatory Information

This product may be regulated, have exposure limits or other information identified as the following: Permanganates, inorganic, n.o.s., Manganese compounds, inorganic

#### Substance Registration Number(s)

This material is produced in amounts > 1 tonne/annum and is therefore subject to REACH registration.

01-2119480139-34-0000



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## Section 4 First Aid Measures

### EYES

Immediately flush eyes with large amounts of water for at least 15 minutes holding lids apart to ensure flushing of the entire surface. Do not attempt to neutralize chemically. Seek medical attention immediately. **Note to physician:** Decomposition products are alkaline. Insoluble decomposition product formed is brown colored manganese dioxide.

### SKIN

Immediately wash contaminated areas with water. Remove contaminated clothing and footwear. Wash clothing and decontaminate footwear before reuse. Seek medical attention immediately if irritation is severe or persistent.

### INHALATION

Remove person from contaminated area to fresh air. If breathing has stopped, resuscitate and administer oxygen if readily available. Seek medical attention immediately.

### INGESTION

Never give anything by mouth to an unconscious or convulsing person. If person is conscious, give large quantities of water. Seek medical attention immediately.

### NOTE TO PHYSICIANS

For inhalation, consider oxygen.

Avoid gastric lavage or emesis.

Decomposition products are alkaline. Insoluble decomposition product formed is brown colored manganese dioxide.

## Section 5 Fire Fighting Measures

### NFPA\* HAZARD SIGNS

Health Hazard	1	=	Materials that under emergency conditions, can cause significant irritation. Materials that on the skin could cause irritation.
Flammability Hazard	0	=	Materials that will not burn under typical fire conditions, including intrinsically noncombustible materials such as concrete, stone and sand.
Instability Hazard	0	=	Materials that in themselves are normally stable, even under fire conditions.
Special Hazard	OX	=	Oxidizer

\*National Fire Protection Association 704 (USA)

### FIRST RESPONDERS

Wear protective gloves, boots, goggles, and respirator. In case of fire, wear positive pressure breathing apparatus. Approach incident with caution.

### FLASHPOINT

None

### FLAMMABLE OR EXPLOSIVE LIMITS

Lower: Nonflammable Upper: Nonflammable

### EXTINGUISHING MEDIA

Use large quantities of water. Water will turn pink to purple when in contact with potassium permanganate. Dike to contain. Do not use dry chemicals, CO<sub>2</sub>, Halon<sup>®</sup> or foams, because they are not effective.

### SPECIAL FIREFIGHTING PROCEDURES

If material is involved in fire, flood with water. Cool all affected containers with large quantities of water. Apply water from as far a distance as possible. Wear self-contained breathing apparatus and full protective clothing.



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## Section 5 Fire Fighting Measures (contd.)

### UNUSUAL FIRE AND EXPLOSION

Powerful oxidizing material. May decompose spontaneously if exposed to heat (135°C / 275°F). May be explosive in contact with certain other chemicals (Section 10). May react violently with finely divided and readily oxidizable substances. Increases burning rate of combustible material.

### THERMAL DECOMPOSITION PRODUCTS:

**Combustion:** oxides of potassium, oxides of manganese. Fire may product irritating, poisonous and/or corrosive fumes.

## Section 6 Accidental Release Measures

### OCCUPATIONAL SPILL/RELEASE

Avoid contact with combustible materials. Do not touch spilled material. Move containers away from spill to a safe area. Keep unnecessary people away, isolate hazard area and deny entry.

### PERSONAL PRECAUTIONS

Ensure adequate ventilation. Avoid dust formation. Personnel should wear protective clothing suitable for the task. Remove all ignition sources and incompatible materials before attempting clean up.

### ENVIRONMENTAL PRECAUTIONS

Do not flush into sanitary sewer system or surface water. If accidental release into the environment occurs, inform the responsible authorities. Keep the product away from drains, sewers, surface and ground water and soil.

### STEPS TO BE TAKEN IF MATERIAL IS RELEASED OR SPILLED

Clean up spills immediately by sweeping or shoveling up the material. Do not return spilled material to the original container; transfer to a clean metal or plastic drum. To clean up potassium permanganate solutions, follow either of the following two options.

Option # 1: Dilute to approximately 6% with water, and then reduce with sodium thiosulfate, a bisulfite or ferrous salt solution. The bisulfite or ferrous salt may require some dilute sulfuric acid (10% w/w) to promote reduction. Neutralize with sodium carbonate to neutral pH, if acid was used. Decant or filter and deposit sludge in approved landfill. Where permitted, the sludge may be drained into sewer with large quantities of water.

Option # 2: Absorb with inert media like diatomaceous earth or inert floor dry, collect into a drum and dispose of properly. Does not use saw dust or other incompatible media. Disposal of all materials shall be in full and strict compliance with all federal, state, and local regulations pertaining to permanganates.

To clean contaminated floors, flush with abundant quantities of water into sewer, if permitted by federal, state, and local regulations. If not, collect water and treat as described above.

## Section 7 Handling and Storage

### WORK/HYGIENIC PRACTICES

Wash hands thoroughly with soap and water after handling potassium permanganate. Do not eat, drink or smoke when working with potassium permanganate. Wear proper protective equipment. Remove clothing if it becomes contaminated.

### VENTILATION REQUIREMENTS

Provide sufficient mechanical and/or local exhaust to maintain exposure below the TLV/TWA.

### CONDITIONS FOR SAFE STORAGE

Store in accordance with NFPA 430 requirements for the Storage of Class II oxidizing materials. Protect containers from physical damage. Store in a cool, dry area in closed containers. Segregate from acids, peroxides, formaldehyde, and all combustible, organic, or easily oxidizable materials including antifreeze and hydraulic fluid.



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## Section 8 Exposure Controls and Personal Protection

### COMPONENT EXPOSURE LIMITS

Potassium permanganate (7722-64-7)

ACGIH: 0.2 mg/m<sup>3</sup> TWA (as Mn)

### VENTILATION

Provide local exhaust or process enclosure ventilation system. Ensure compliance with applicable exposure limits.

### PERSONAL PROTECTIVE EQUIPMENT

#### EYES/FACE

Face shield, goggles, or safety glasses with side shields should be worn. Provide eyewash in working area.

#### GLOVES

Rubber or plastic gloves should be worn.

### OTHER PROTECTIVE EQUIPMENT

Chemically resistant clothing covering arms and legs, and rubber or plastic apron should be worn. **Caution:** If clothing becomes contaminated, wash off immediately.

### RESPIRATORY PROTECTION

In cases where overexposure to dust may occur, the use of an approved NIOSH-MSHA dust respirator or an air supplied respirator is advised. Engineering or administrative controls should be implemented to control dust.

Measurement Element: Manganese (Mn)

10 mg/m<sup>3</sup>

Any particulate respirator equipped with an N95, R95, or P95 filter (including N95, R95, and P95 filtering facepieces) except quarter-mask respirators. The following filters may also be used: N99, R99, P99, N100, R100 or P100.

Any supplied-air respirator.

25 mg/m<sup>3</sup>

Any supplied-air respirator operated in a continuous-flow mode.

Any powered, air-purifying respirator with a high-efficiency particulate filter.

50 mg/m<sup>3</sup>

Any air-purifying, full-facepiece respirator equipped with an N100, R100, or P100 filter.

Any supplied-air respirator with a tight-fitting face piece that is operated in a continuous-flow mode.

Any powered, air-purifying respirator with a tight-fitting face piece and a high-efficiency particulate filter.

Any self-contained breathing apparatus with a full face piece.

Any supplied-air respirator with a full face piece.

500 mg/m<sup>3</sup>

Any supplied-air respirator operated in a pressure-demand or other positive-pressure mode.

Emergency or planned entry into unknown concentrations or IDLH conditions -

Any self-contained breathing apparatus that has a full face piece and is operated in a pressure-demand or other positive-pressure mode.

Escape

Any air-purifying, full-face piece respirator equipped with an N100, R100, or P100 filter.

Any appropriate escape-type, self-contained breathing apparatus.



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## Section 9 Physical and Chemical Properties (CONTD.)

<b>APPEARANCE</b>	Dark purple solid with metallic luster
<b>ODOR</b>	Odorless
<b>pH OF THE SUBSTANCE</b>	Not applicable
<b>BOILING POINT/BOILING RANGE</b>	Not applicable
<b>FLASH POINT</b>	Not applicable
<b>FLAMMABILITY (SOLID, GAS)</b>	Not flammable
<b>EXPLOSIVE PROPERTIES</b>	Explosive in contact with sulfuric acid or peroxides, or readily oxidizable substances
<b>OXIDIZING PROPERTIES</b>	Strong oxidizer
<b>VAPOR PRESSURE</b>	Not applicable
<b>RELATIVE DENSITY (AT 20 °C)</b>	2.7
<b>SOLUBILITY</b>	
<b>WATER SOLUBILITY</b>	6% (by weight) at 20 °C and 20% (by weight) at 65 °C
<b>PARTITION COEFFICIENT: n-OCTONAL/WATER</b>	
<b>VISCOSITY</b>	Not applicable
<b>VAPOUR DENSITY</b>	Not applicable
<b>EVAPORATION RATE</b>	Not applicable
<b>MELTING POINT</b>	Starts to decompose with evolution of oxygen (O <sub>2</sub> ) at temperatures above 150°C. Once initiated, the decomposition is exothermic and self sustaining.
<b>MOLECULAR WEIGHT</b>	158.034

## Section 10 Stability and Reactivity

### STABILITY

Under normal conditions, the material is stable.

### CONDITIONS TO AVOID

Contact with incompatible materials or heat (150°C / 302°F) could result in violent exothermic chemical reaction.

### MATERIALS TO AVOID

Acids, peroxides, formaldehyde, anti-freeze, hydraulic fluids and all combustible organic or readily oxidizable inorganic materials including metal powders. With hydrochloric acid, chlorine gas is liberated.

### HAZARDOUS DECOMPOSITION PRODUCTS

When involved in a fire, potassium permanganate may liberate irritating, poisonous and/or corrosive fumes. Oxides of potassium and manganese may be formed.

### CONDITIONS CONTRIBUTING TO HAZARDOUS POLYMERIZATION

Material is not known to polymerize.

## Section 11 Toxicological Information

### EXPOSURE SYMPTOMS DESCRIPTION

#### INHALATION

The product may be absorbed into the body by inhalation. Major effects of exposure: respiratory disorder, cough.

#### INGESTION

Harmful, if swallowed. The estimated lethal human dose is 10 g. Ingestion may cause nausea, vomiting, sore throat, stomach-ache, and eventually lead to a perforation of the intestine. Liver and kidney injuries may occur.



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## Section 11 Toxicological Information (contd.)

### SKIN CONTACT

The product may be absorbed into the body through the skin. Major effects of exposure: severe irritation, damage to the skin, and brown staining of skin.

### EYE CONTACT

Contact with eye is damaging to eye tissues. It may cause severe burns that result in damage to the eye.

### ACUTE TOXICITY

LC 50 inhalation: No data available.

LD 50 dermal: No data available.

LD 50 oral rat: 780 mg/kg male (14 days); 525 mg/kg female (14 days).

Harmful if swallowed. ALD: 10g. Ingestion may cause nausea, vomiting, sore throat, stomach-ache and eventually lead to a perforation of the intestine. Liver and kidney injuries may occur.

### CHRONIC TOXICITY

No known cases of chronic poisoning due to permanganates have been reported. Prolonged exposure, usually over many years, to heavy concentrations of manganese oxides in the form of dust and fumes may lead to chronic manganese poisoning, chiefly involving the central nervous system.

### CARCINOGENICITY

Potassium permanganate has not been classified as a carcinogen by ACGIH, NIOSH, OSHA, NTP, or IARC.

### MEDICAL CONDITIONS GENERALLY AGGRAVATED BY EXPOSURE

Potassium permanganate will cause further irritation of tissue, open wounds, burns or mucous membranes.

## Section 12 Ecological Information

### ECO TOXICITY

Very toxic to aquatic organisms.

### COMPONENT ANALYSIS - AQUATIC TOXICITY

#### Potassium permanganate (7722-64-7)

96Hr LC50	Rainbow trout	1.8 mg/L
96Hr LC50	Bluegill sunfish	2.3 mg/L
96Hr LC50	Milk fish (Chanos Chanos)	>1.4 mg/L
96Hr LC50	Carassius auratus	3.3-3.93 mg/L (static)
96Hr LC50	Cyprinus carpio	2.97-3.11 mg/L
96Hr LC50	Cyprinus carpio	3.16-3.77 mg/L
96Hr LC50	Lepomis macrochirus	2.3 mg/L (flow-through)
96Hr LC50	Lepomis macrochirus	1.8-5.6 mg/L (static)
96Hr LC50	Lepomis macrochirus	2.7 mg/L (static)
96Hr LC50	Oncorhynchus mykiss	1.08-1.38 mg/L
96Hr LC50	Oncorhynchus mykiss	0.77-1.27 mg/L

### MOBILITY

Miscible in water.

### PERSISTENCE AND DEGRADABILITY

Permanganate has a low estimated lifetime in the environment, being readily converted by oxidizable materials to insoluble MnO<sub>2</sub>.



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## Section 12 Ecological Information

### BIOACCUMULATIVE POTENTIAL

In non-reducing and non-acidic environments, MnO<sub>2</sub> is insoluble and has a very low bioaccumulative potential.

### OTHER ADVERSE EFFECTS

Harmful to aquatic organisms.

## Section 13 Disposal Considerations

### WASTE DISPOSAL

Offer surplus and non-recyclable product or solutions to a licensed disposal company. Disposal of all materials shall be in full and strict compliance with all federal, state, and local regulations. This material and its container must be disposed of as hazardous waste. US EPA guidelines for the classification determination are listed in 40 CFR Parts 261.3. When it becomes a waste, potassium permanganate is considered a D001 hazardous (ignitable) waste. For disposal of potassium permanganate solutions, follow procedures in Section 6 and deactivate the permanganate to insoluble manganese dioxide. Dispose of it in a permitted landfill. Contact Carus Corporation for additional recommendations. Packaging materials must be triple rinsed to remove all residues prior to re-cycling or disposal as a non-hazardous waste.

RCRA P-Series: None listed. RCRA U-Series: None listed.

## Section 14 Transport Information

<b>USA (Land, DOT) and Canada (TDG)</b>	<b>ID Number:</b> UN 1490 <b>Proper Shipping Name:</b> Potassium permanganate <b>Hazard Class:</b> Oxidizer <b>Packing Group:</b> II <b>Division:</b> 5.1 <b>Product packaging containing ≥100 lbs</b> <b>ID Number:</b> UN 1490 <b>Proper Shipping Name:</b> Potassium permanganate, RQ <b>Hazard Class:</b> Oxidizer <b>Packing Group:</b> II <b>Division:</b> 5.1 <b>Additional Info.:</b> If this product is spilled or leaked into the environment, the CERCLA (40 CFR 302.4) reportable quantity is 100 lbs, and requires National Response Center notification within United States of America.
<b>European Labeling in accordance Road/Rail Transport (ADR/RID)</b>	<b>ID Number:</b> UN 1490 <b>ADR/RID Class:</b> 5.1 <b>Description of Goods:</b> Potassium permanganate <b>Packing Group:</b> II <b>Hazard Identification No.:</b> 50
<b>European Labeling in accordance with EC directive (Water, IMDG)</b>	<b>ID Number:</b> UN 1490 <b>Proper Shipping Name:</b> Potassium permanganate <b>Hazard Class:</b> Oxidizer <b>Packing Group:</b> II <b>Division:</b> 5.1 <b>Marine Pollutant:</b> No
<b>European Labeling in accordance with EC directive (IACO, IATA)</b>	<b>ID Number:</b> UN 1490 <b>Proper Shipping Name:</b> Potassium permanganate <b>Hazard Class:</b> Oxidizer <b>Packing Group:</b> II <b>Division:</b> 5.1



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## Section 15 Regulatory Information

### EUROPEAN AND INTERNATIONAL REGULATIONS

#### GERMANY WATER CLASSIFICATION

Potassium permanganate (7722-64-7)

Number 1936, hazard class 3 - severe hazard to waters

#### CLP CLASSIFICATION

This product is hazardous according to the Regulation (EC) No. 1272/2008 on Classification, Labeling and Packaging of Substances and Mixtures (CLP).

Oxidizing solid, Category 2

Acute toxicity, Category 4

Hazardous to the Aquatic Environment - Hazard, Category 1

Hazardous to the Aquatic Environment - Hazard, Category 1

#### CLP HAZARD SYMBOLS



#### CLP HAZARD STATEMENTS

- H272 May intensify fire, oxidizer
- H302 Harmful, if swallowed
- H410 Very toxic to aquatic life with long lasting effects
- P210 Keep away from heat/sparks/open flames/hot surfaces. – No smoking
- P220 Keep/Store away from clothing/combustible materials.
- P260 Do not breathe dust
- P280 Wear protective gloves/protective clothing/eye protection/face protection
- P370 + P378 In case of fire: Use water for extinction
- P501 Dispose of contents/container to appropriate places
- P273 Avoid release to the environment.

#### COMPONENT ANALYSIS – INVENTORY

COMPONENT	CAS#	US	CA	EU	AU	PH	JP	KR	CN	NZ
Potassium permanganate	7722-64-7	TSCA	DSL	EIN	Yes	Yes	Yes	Yes	Yes	Yes

This product has also been classified in accordance with the hazard criteria of the Controlled Products Regulation (CPR, Canada) and the MSDS contains all of the information required by the CPR.



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## Section 15 Regulatory Information (contd.)

### US FEDERAL REGULATIONS:

#### FEDERAL, STATE & INTERNATIONAL REGULATIONS – PART 1

<u>Ingredient</u>	<u>CAS. NO.</u>	<u>SARA 302</u>		<u>SARA 313</u>	
		<u>RQ</u>	<u>TPQ</u>	<u>List</u>	<u>Chemical Category</u>
Potassium permanganate	7722-64-7	No	No	Yes	Yes (Manganese compounds)

#### FEDERAL, STATE & INTERNATIONAL REGULATIONS – PART 2

<u>Ingredient</u>	<u>CAS. NO.</u>	<u>CERCLA</u>	<u>RCRA</u>	<u>TSCA 8(d)</u>
Potassium permanganate	7722-64-7	Yes (RQ = 100 lbs)	D001	No

<u>Ingredient</u>	<u>CAS. NO.</u>	<u>CWC</u>	<u>TSCA 12(b)</u>	<u>CDTA</u>	<u>SARA 311/312</u>
Potassium permanganate	7722-64-7	No	No		4545 Kg

<u>Ingredient</u>	<u>CAS. NO.</u>	<u>Acute</u>	<u>Chronic</u>	<u>Fire</u>	<u>Pressure</u>	<u>Reactivity</u>	<u>Pure/Liquid</u>
Potassium permanganate	7722-64-7	Yes	Yes	Yes	No	No	Pure

<u>Ingredient</u>	<u>CAS. NO.</u>	<u>Australian Hazchem</u>	<u>WHMIS</u>	<u>IDL</u>
Potassium permanganate	7722-64-7	IYE	C, D2B	Yes

## Section 16 Other Information

ADR/RID	Agreement on Dangerous Goods by Road /Regulations Concerning the International Transport of Dangerous Goods by Rail
C	Ceiling Exposure Limit
CAS	Chemical Abstract Service
CFR	Code of Federal Regulations
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CHEMTREC	Chemical Transportation Emergency Center
EINECS	Inventory of Existing Chemical Substances (European)
DOT	Department of Transportation
DSL/NDSL	The Domestic Substances and the Non-Domestic Substances List (Canada)
HIMS	Hazardous Materials Information System
IARC	International Agency for Research on Cancer
IATA	International Air Transport Association
ICAO	International Civil Aviation Center
IDL	Ingredient Disclosure List
IMDG	International Maritime Dangerous Goods
OSHA	Occupational Safety and Health Administration
NIOSH	National Institute for Occupational Safety and Health
NTP	National Toxicology Program
MSHA	Mine Safety and Health Administration
PEL	Permissible Exposure Limit
SARA	Superfund Amendments and Reauthorization Act
TDG	Transport Dangerous Goods (Canada)
TSCA	Toxic substances control Act
TLV-TWA	Threshold Limit Value-Time Weighted Average
UN	United Nations
WHMIS	Workplace Hazardous Materials Information System



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## Section 16 Other Information (contd.)

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This safety data sheet was reviewed according to Annex II of the regulation of the European Parliament and European Council (EC) No. 1907/2006-REACH and 1272/2008.

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