

# OPERATIONS MANUAL

## CASCADE BUCKET SYSTEM

KCB-0260-0000-24 (260 GALLON)

KCB-0320-0000-24 (320 GALLON)

KCB-0350-0000-24 (350 GALLON)



**KAWAK AVIATION**  
TECHNOLOGIES

*PROGRESS THROUGH INNOVATIVE THINKING*



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**RECORD OF REVISIONS**

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# Contents

<b>SECTION 1: SAFETY FIRST</b> .....	<b>7</b>
<b>Terminology</b> .....	<b>7</b>
<b>Tips and Precautions</b> .....	<b>7</b>
<b>SECTION 2: GENERAL INFORMATION</b> .....	<b>7</b>
<b>The Company</b> .....	<b>7</b>
<b>This Document</b> .....	<b>8</b>
Definitions .....	8
<b>The Product</b> .....	<b>9</b>
Introduction .....	9
System Description .....	9
Product Specifications.....	9
Limits.....	10
Maximum Airspeed .....	10
Reporting Incidents .....	10
<b>SECTION 3: UNBOXING YOUR ORDER</b> .....	<b>11</b>
<b>What's Included</b> .....	<b>11</b>
<b>Unpacking</b> .....	<b>11</b>
<b>Product Labels and Markings</b> .....	<b>11</b>
Serial Markings.....	11
<b>SECTION 4: SYSTEM OVERVIEW</b> .....	<b>12</b>
<b>Equipment Descriptions</b> .....	<b>12</b>
Rigging and Support .....	13
Rigging Ropes .....	13
Collapsible Inlet Frame.....	13
Sling Connectors.....	14
Bucket Skin .....	15
Strap Clamp Fittings .....	15
Lift Straps .....	16
Support Battens .....	16
Lower Structure .....	16



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Valve Base Weldment .....	17
Standoff .....	17
T-Bolt Clamp Band .....	18
Valve Assembly .....	18
Pump Mount Plate .....	18
Bucket Refill Pump Inlet Screen .....	19
Actuation Assembly .....	19
Bucket Refill Pump System .....	21
Wiring Harness Connection Points .....	24
<b>SECTION 5: INSTALLATION AND SET-UP .....</b>	<b>25</b>
<b>Aircraft Modifications Required .....</b>	<b>25</b>
<b>Bucket Set-Up .....</b>	<b>25</b>
Electrical Installation .....	25
Polarity Check for the 28 VDC Bucket Refill Pump .....	31
Initial Receiving and Bucket Setup .....	31
<b>SECTION 6: OPERATING THE BUCKET .....</b>	<b>33</b>
<b>System Operation .....</b>	<b>33</b>
Product User Function and Interface .....	33
Actuator Operation .....	33
Bucket Refill Pump Operation .....	33
Deploying the Bucket .....	33
Collapsing the Bucket .....	34
Pre-Flight Check .....	35
Lifting the Bucket .....	36
In-Flight Operation .....	36
Filling and Dumping .....	36
Filling .....	36
Dumping .....	37
<b>SECTION 7: MAINTENANCE AND REPAIRS .....</b>	<b>37</b>
<b>Maintenance Procedures .....</b>	<b>37</b>
General Maintenance .....	37
Post-Flight Procedures .....	37
Servicing the Actuator Assembly .....	38
Servicing the Bucket Refill Pump .....	40
28VDC Bucket Refill Pump Disassembly .....	40
Pump Assembly Inspection .....	43
Bell Housing and Check Valve Inspection .....	45
Bucket Refill Pump Assembly .....	45



---

<b>Bucket Skin Repair</b> .....	<b>48</b>
Glue-only repairs.....	48
Glue Patch Repairs .....	48
Hot Air Patch Repairs .....	49
<b>Skin Replacement</b> .....	<b>50</b>
Disassembling the Skin.....	50
Reassembling the Skin .....	51
<b>SECTION 8: STOWAGE</b> .....	<b>54</b>
<b>Pre-Stowage Maintenance</b> .....	<b>54</b>
<b>Stowage</b> .....	<b>54</b>
<b>SECTION 9: TROUBLESHOOTING</b> .....	<b>55</b>
<b>General</b> .....	<b>55</b>
<b>Actuation System</b> .....	<b>55</b>
<b>28VDC Bucket Refill Pump</b> .....	<b>57</b>
<b>SECTION 10: KITS AND ACCESSORIES</b> .....	<b>58</b>
<b>SECTION 11: THE WARRANTY</b> .....	<b>58</b>
<b>SECTION 12: ILLUSTRATED PARTS CATALOG</b> .....	<b>59</b>
<b>RIGGING</b> .....	<b>59</b>
<b>INLET FRAME, 320 – 350 Gallon Bucket Capacity</b> .....	<b>61</b>
<b>INLET FRAME, 260 Gallon Bucket Capacity</b> .....	<b>62</b>
<b>SKIN ASSEMBLY</b> .....	<b>63</b>
<b>ELECTRICAL</b> .....	<b>65</b>
<b>LOWER STRUCTURE</b> .....	<b>67</b>
<b>ACTUATION ASSEMBLY</b> .....	<b>69</b>
<b>BUCKET REFILL PUMP</b> .....	<b>71</b>



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Motor Guard, 28 VDC Motor .....	71
Pump Assembly .....	73
Impeller and Stator Assembly .....	74
Check Valve Assembly .....	76



## Section 1: SAFETY FIRST

### Terminology

Warnings, cautions, and notes are used throughout this manual to emphasize important and critical instructions, and are used as follows:

TERM	DEFINITION
<b>⚠ WARNING</b>	An operating procedure, practice, etc., if not correctly followed, could result in personal injury or loss of life.
<b>⚠ CAUTION</b>	An operating procedure, practice, etc., if not strictly observed, could result in damage or destruction of equipment.
<b>**NOTE**</b>	An operating procedure, condition, which is essential to highlight.

### Tips and Precautions

- ⚠ CAUTION:** Rigging rope assemblies and bucket assemblies are matched, and no attempt should be made to replace assemblies or components unless they are replaced with Kawak genuine components.
- ⚠ CAUTION:** Although the bucket system has demonstrated neutral flying qualities, normal in-flight external or sling-load precautions and procedures should be conducted to preclude any unexpected oscillations affecting the safety of the aircraft, its crew or anything on the ground.
- ⚠ WARNING:** If operating a bucket without a longline, the operator is responsible for confirming appropriate clearance between the bucket and the tail rotor and/or the fuselage during flight. Failure to do so could result in damage to the tail boom or a rotor strike.

## Section 2: GENERAL INFORMATION

### The Company

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Bend, Oregon 97702

Website: [kawakaviation.com](http://kawakaviation.com)  
Email: [support@kawakaviation.com](mailto:support@kawakaviation.com)  
Phone: 541.385.5051



## This Document

This manual provides instructions on how to safely install, operate, and maintain your bucket system. The information contained within this manual is based upon data available at the time of publication and will be kept current by revision changes or service bulletins.

Carefully read and follow all instructions in this manual and any accompanying materials to protect personnel and product. Failure to do so may result in physical harm to you and/or your product and will void the product warranty.

This manual contains information and procedures for the safe and effective installation, operation, and maintenance of the bucket system. It shall not be used as a substitute for sound judgment. Kawak reserves the right to make changes at any time without notice.

This document and any revisions made to it are available for download from the Kawak website. Revisions will carry a new revision letter and will be shown at the bottom of each page of the manual. Revisions supersede any previous revision levels of the manual. Operators and installers should check the Kawak website for the latest revision prior to installing/operating the bucket system.

Although this manual and any revisions are prepared as separate publications, they should be kept and used in conjunction with this maintenance manual.

### Definitions

The following terms and abbreviations are used throughout this document. It is important that their intended uses be understood:

TERM	DEFINITION
Shall	Used only when application of a procedure is <b><u>mandatory</u></b> .
Should	Used only when application of a procedure is <b><u>recommended</u></b> .
Will	Used only to indicate <b><u>futurity</u></b> , not used to indicate mandatory procedure.
Product	A complete assembly that is ready for sale.
Component	Parts or subassemblies of a product.
May / Need Not	Used only when application of a procedure is <b><u>optional</u></b> .



## The Product

### Introduction

The Cascade Bucket System is a collapsible liquid delivery system for helicopter firefighting activities that require quick deployment, as well as ease of storage and transport.

### System Description

The Cascade Bucket System consists of rigging equipped with abrasion-resistant knuckle covers and support components, a pliable containment skin made from a nylon-based fabric coated in thick polyurethane, a lower structure, a linear actuator, and electrical connections and controls.

### Product Specifications

<b>BUCKET SYSTEM ELECTRICAL REQUIREMENTS</b>	
Bucket Refill Pump Motor Draw (28 VDC)	**80 – 150 amps at 28VDC
Linear Actuator Draw	up to 15 amps at 28VDC

Table 1: Bucket System Electrical Requirements

\*\*See Table 4 for detailed current draw, pump performance and suggested wire gauge.

<b>KAWAK CASCADE BUCKET SPECIFICATION MATRIX</b>																		
CASCADE BUCKET	CAPACITY		EMPTY WEIGHT		GROSS WEIGHT		OVERALL LENGTH		STOWED HEIGHT		STOWED WIDTH		MIN. DIP FILL WATER DEPTH		MIN. POWER FILL WATER DEPTH		INLET DIAMETER	
	US Gal	Liters	lb	kg	lb	kg	ft	m	in	m	in	m	ft	m	in	m	ft	m
BUCKET	260	984	188	85	2356	1069	22'-8"	6.91	40.0	1.02	35.0	0.89	4'-8"	1.42	14.5	0.37	4'-4.5"	1.33
W/PUMP			266	121	2434	1104												
BUCKET	320	1230	190	86	2859	1297	23'	7.00	40.0	1.02	35.0	0.89	5'	1.52	14.5	0.37	4'-9"	1.45
W/PUMP			268	122	2937	1332												
BUCKET	350	1325	192	87	3111	1411	23'-5"	7.14	40.0	1.02	35.0	0.89	5'-5"	1.65	14.5	0.37	4'-9"	1.45
W/PUMP			270	122	3189	1446												

Table 2: Bucket System Weights and Dimensions



## Limits

### *Maximum Airspeed*

The maximum recommended airspeed while flying with the Cascade bucket carrying a full load of water is eighty (80) knots or the airspeed limitation specified by the rotorcraft load combination flight manual, whichever is less. When the bucket is empty, the maximum recommended airspeed is one hundred (100) knots.

### *Reporting Incidents*

Kawak strongly encourages prompt reporting of any incidents experienced with the operation of the Cascade bucket. This will allow Kawak to quickly address any incidents on an individual basis and provide the necessary support to keep your buckets operating optimally. We strive to continually improve our products, and operator involvement in this effort is highly valued. Contact information can be found in the beginning of this manual.



## Section 3: UNBOXING YOUR ORDER

### What's Included

The following parts are included in your order:

- Cascade Bucket System
- Repair Kit

### Unpacking

The bucket system will arrive on a 48" x 48" wood pallet platform secured in a cargo net with straps attached to the D-ring anchor points on the pallet. This cargo net and straps are utilized to protect the bucket during transportation and storage. Customers may wish to retain and reuse the wood pallet platform, cargo net, and straps for storage during down time or off season or transporting between sites. Inspect the product for damage prior to installation/use.

### Product Labels and Markings

#### Serial Markings

Serial number information can be found on one of the strap clamp plates on the inside of the bucket skin.

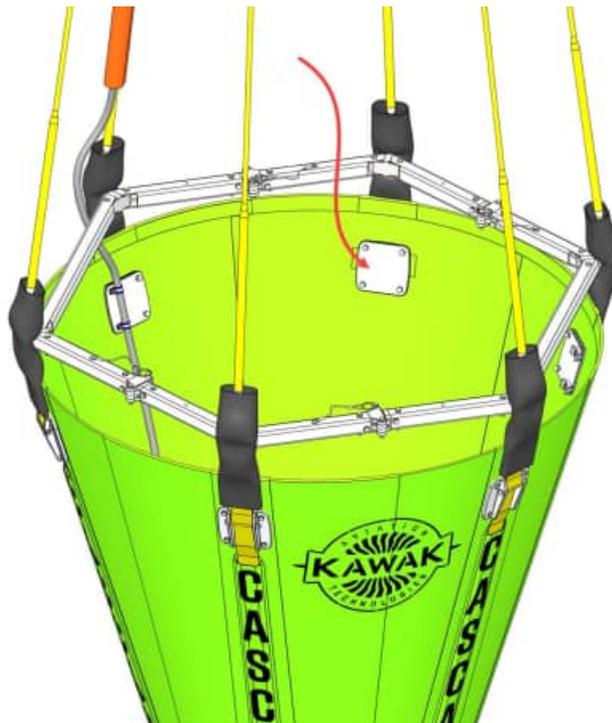


Figure 1: Serial Marking Location



## Section 4: SYSTEM OVERVIEW

### Equipment Descriptions

The three main sections of the bucket system are the Rigging and Support, the Bucket Skin, and the Lower Structure (see Figure 2). Key features of these sections are outlined below.

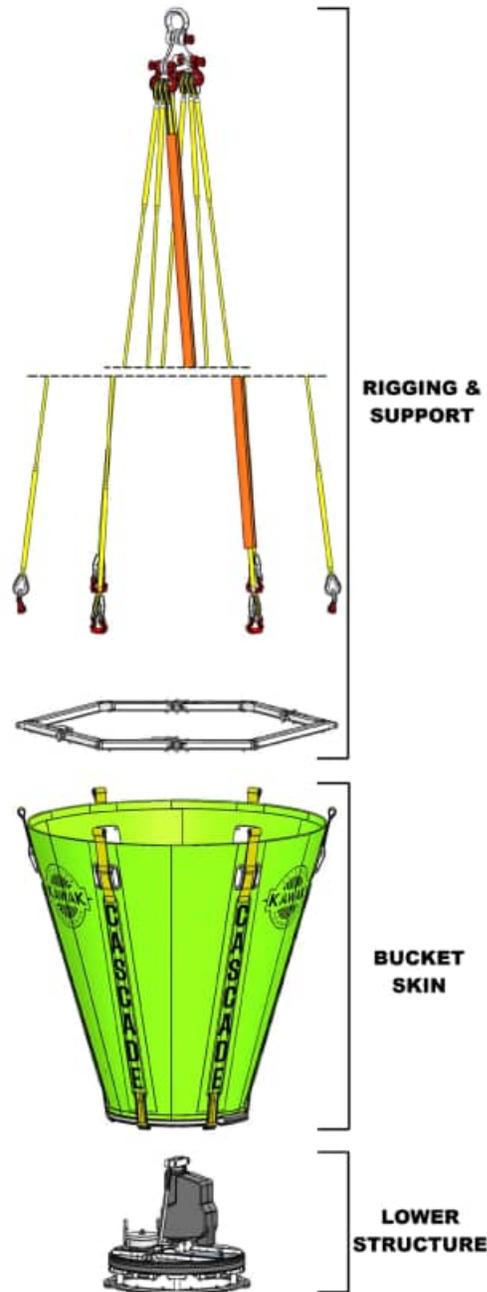


Figure 2: Bucket System Sections



### Rigging and Support

The Rigging and Support (Figure 3 and Figure 4) includes the lifting block, screw pin shackle, sling shackles, UHMPE rigging ropes, the collapsible inlet frame and sling connectors. The lifting block provides a common connection point for the rigging ropes via sling shackles. The screw pin shackle at the top connects to the helicopter's cargo hook (or longline, if so equipped).

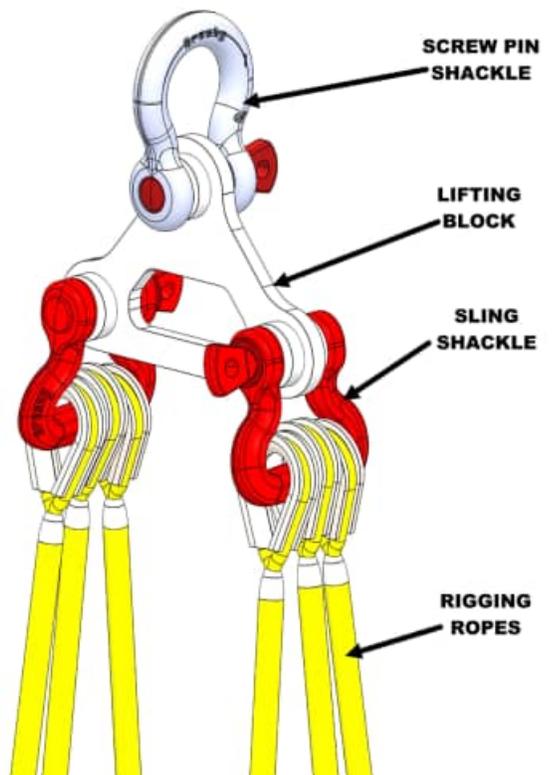


Figure 3: Lifting Block, Shackles, Rigging Ropes

#### *Rigging Ropes*

The Rigging Ropes are manufactured from UHMPE rope. The ends have eye splices with stainless steel thimbles that allow connections to be made to the top and bottom shackles directly while preventing wear to the eye splices.

#### *Collapsible Inlet Frame*

The Collapsible Inlet Frame (Figure 4) is a segmented ring with the main purpose of keeping the top of the bucket skin open. The main components of the frame are the Frame Arms and the Inlet Joint Fittings. All but two of the frame arms are hinged in the middle to facilitate collapsing the frame for storage or transportation. The frame arms connect to each other via the inlet joint fittings, which also provide connection points for the sling connectors.

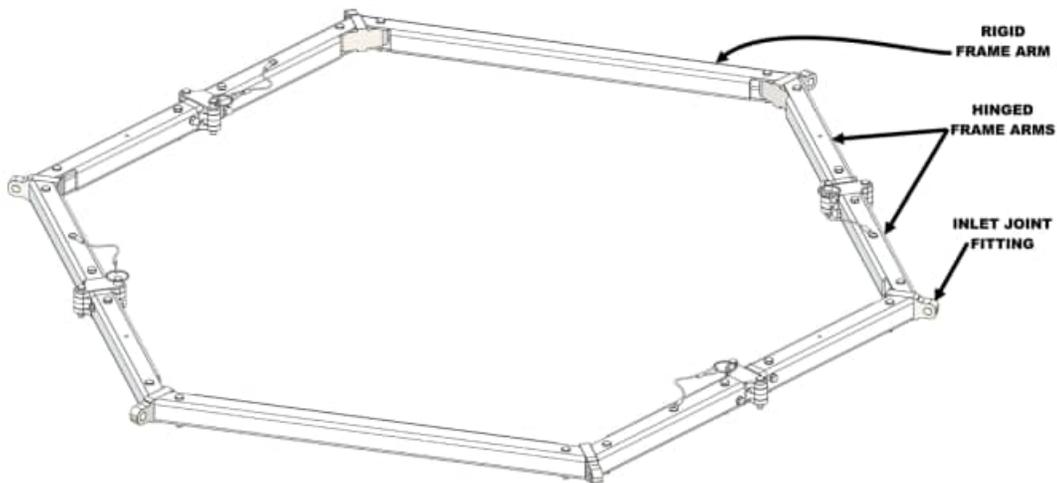


Figure 4: Collapsible Inlet Frame (all other components hidden for clarity)

### *Sling Connectors*

The rigging ropes are connected to the lift straps using high-strength sling connectors (Figure 5). Each sling connector consists of an upper shackle that connects to the rigging rope, a lower shackle that connects to the lifting strap, a pin, and a bushing. The pins and bushings pass through the inlet joint fittings to keep the sling connectors anchored and equally spaced on the inlet frame.

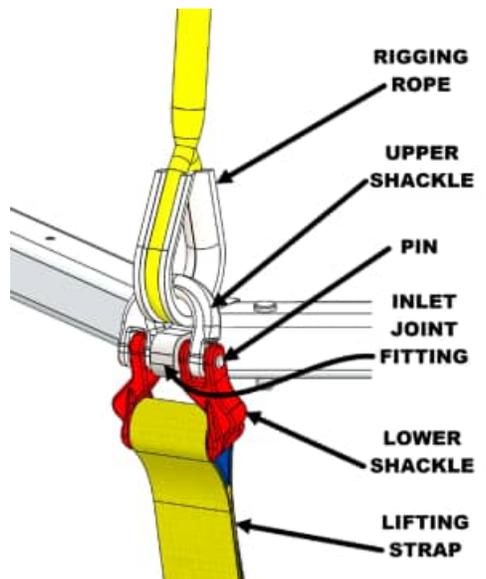


Figure 5: Sling Connector (Bucket Skin and Knuckle Covers hidden for clarity. Bushing not shown.)

Knuckle Covers are provided to reduce wear and tear at the sling connectors and lift straps due to dragging during takeoff, landing, and ground handling. The knuckle covers also provide directional support for the rigging rope thimbles to ensure they do not loop under the sling shackles or inlet.



### Bucket Skin

The Bucket Skin contains the water and bears a large portion of the water weight. The main body of the bucket skin is made of a nylon-based fabric covered with a thick polyurethane coating. The strap sleeves are made from the same material as the body.

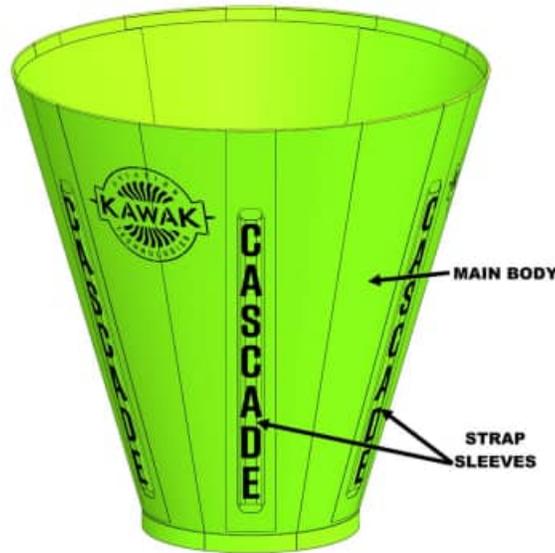


Figure 6: Bucket Skin

### *Strap Clamp Fittings*

The skin is supported by the lift straps via the strap clamp fittings (Figure 7). These clamp fittings are each secured to the skin using four bolts.

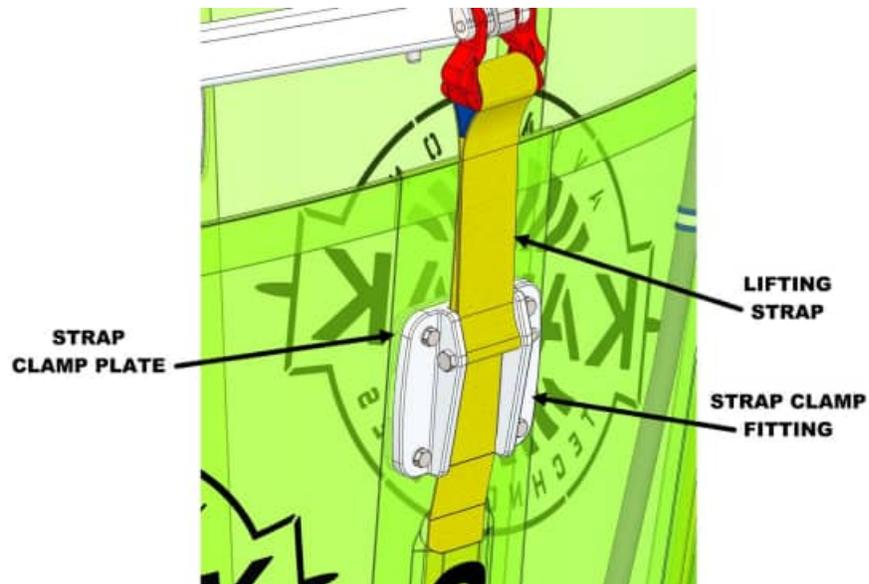


Figure 7: Strap Clamp Fitting (Knuckle Cover hidden, Bucket Skin made transparent)



### *Lift Straps*

The Lift Straps that run through the external sleeves of the bucket skin connect to the sling connectors and the valve base. They support the bucket skin and help bear the weight of the water and valve base.

### *Support Battens*

To hold the bucket skin off the ground when the bucket is set down on the ground, and to improve maintenance access, Support Battens have been incorporated into the bottom section of the lift straps. Like the straps, the battens are individually replaceable and fit into pockets on the lift straps. This interface can be seen in Figure 8. When the bucket is set down, these battens hold the bottom 30” of skin up off the ground and form a cup shape. The height of the skin held off the ground is still low enough that the bucket can be easily serviced in this state.

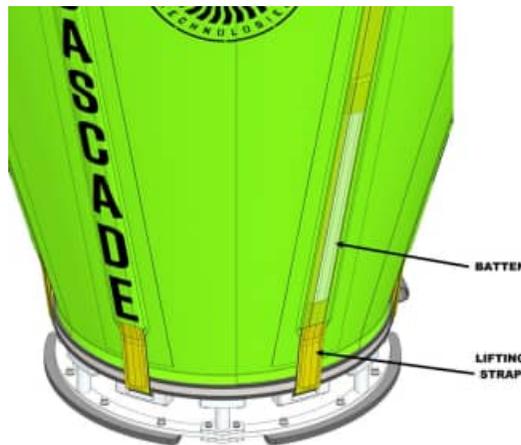


Figure 8: Skin Support Battens (Strap Sleeve made transparent)

### Lower Structure

The group of subsystems at the bottom of the bucket system is the Lower Structure, which is responsible for power filling and emptying the bucket. The lower structure consists of the valve assembly, valve base, standoff assembly, actuation assembly and bucket refill pump. See Figure 9.

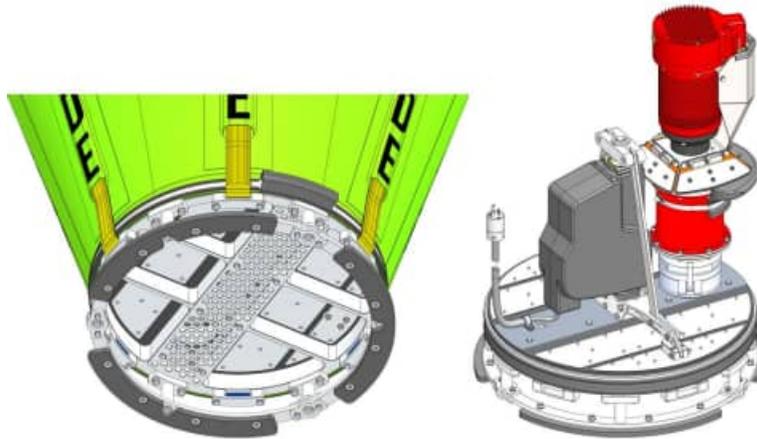


Figure 9: Lower Structure

*Valve Base Weldment*

Figure 10 shows the machined Valve Base, which is the foundation of the lower structure. The valve assembly is attached to the top of the valve base, and seals against the perimeter to prevent water leakage. The lower strap brackets at the bottom of the valve base provide connection points for the sewn loops on the lower ends of the lift straps.

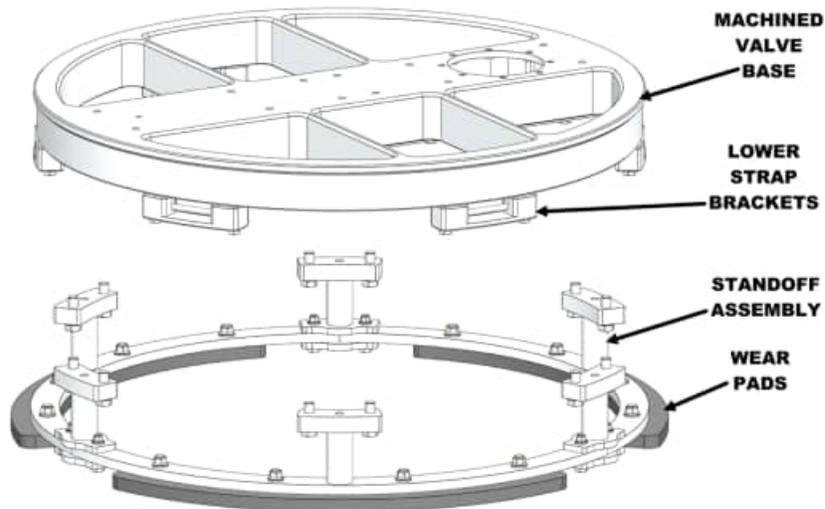


Figure 10: Valve Base Weldment, Standoff, and Wear Pads

*Standoff*

The Standoff is used to prevent the pump inlet from getting too close to the bottom of the water source and to provide the bucket refill pump with an unrestricted supply of water. The design helps prevent cavitation, promotes consistent bucket refill performance, and keeps unwanted debris out of the pump system.



*T-Bolt Clamp Band*

A T-Bolt Clamp Band is fitted around the base of the skin to secure the seal between the skin and the perimeter of the valve base. This prevents slippage and provides a robust seal. (Figure 11). The Clamp Guard covers the end of the t-bolt to prevent it from becoming a catch point or wear point during use, storage, or transportation of the bucket.

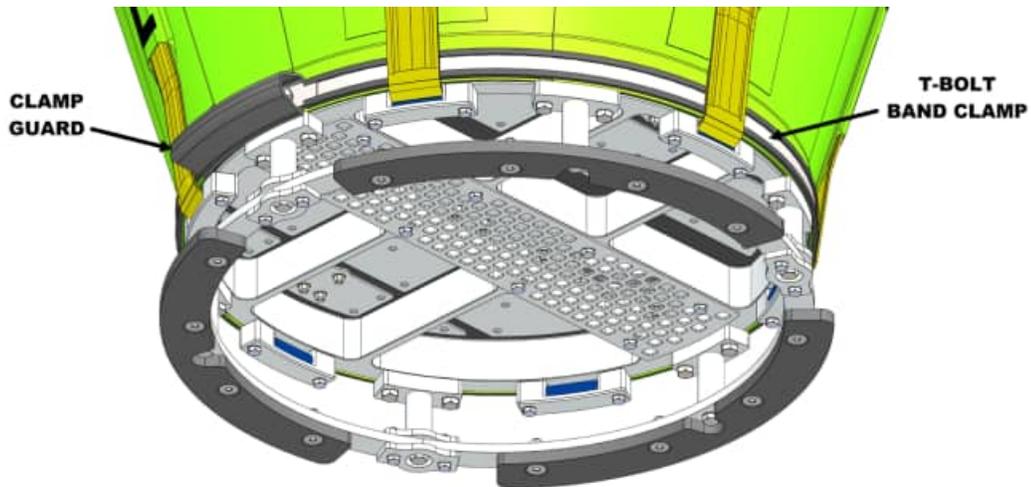


Figure 11: T-Bolt Clamp Band and Clamp Guard

*Valve Assembly*

The Valve Assembly consists of 2-ply fabric-reinforced EPDM rubber, aluminum hinge plates and backer plates, held together with rivets. These plates stiffen the rubber and have gaps between them, allowing the rubber to behave like a hinge for more controlled opening of the valve.

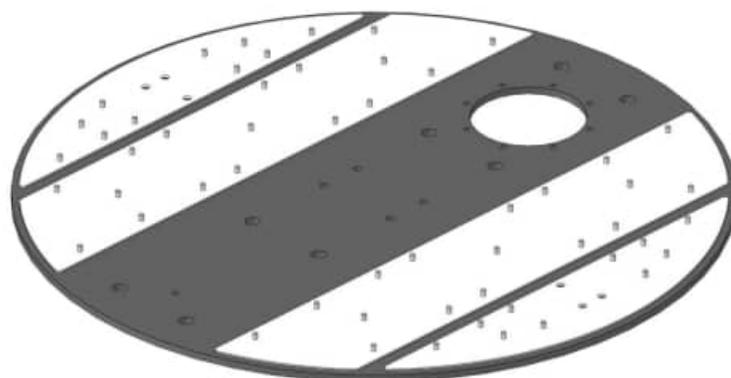


Figure 12: Valve Assembly

*Pump Mount Plate*

The Pump Mount Plate secures the valve assembly and provides a flat, solid surface to which the actuation assembly and bucket fill pump are mounted.

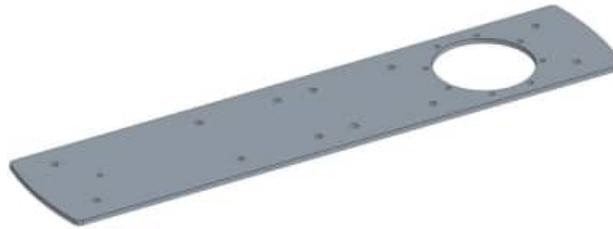


Figure 13: Pump Mount Plate

*Bucket Refill Pump Inlet Screen*

A screen secured to the bottom of the valve base keeps debris larger than ½” from entering the bucket fill pump, preventing damage to the impeller and other pump components.

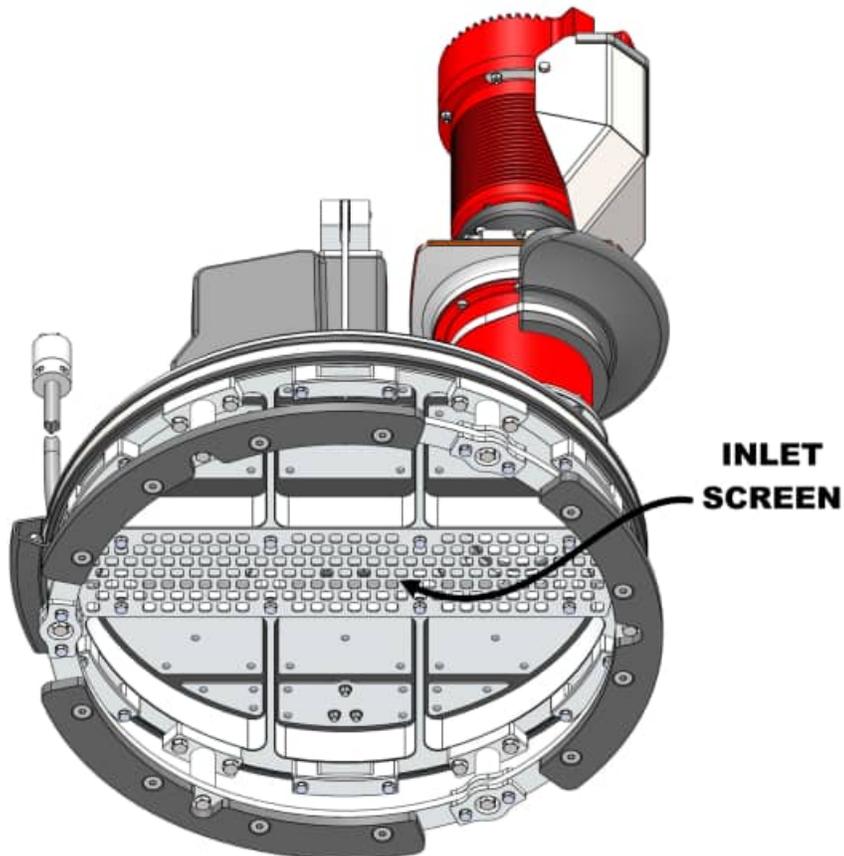


Figure 14: Bucket Refill Pump Inlet Screen

*Actuation Assembly*

The valve assembly is connected to the actuation assembly, which receives power and control signals from the aircraft. The entire module is designed to be submersible and is positioned at the bottom of the bucket.

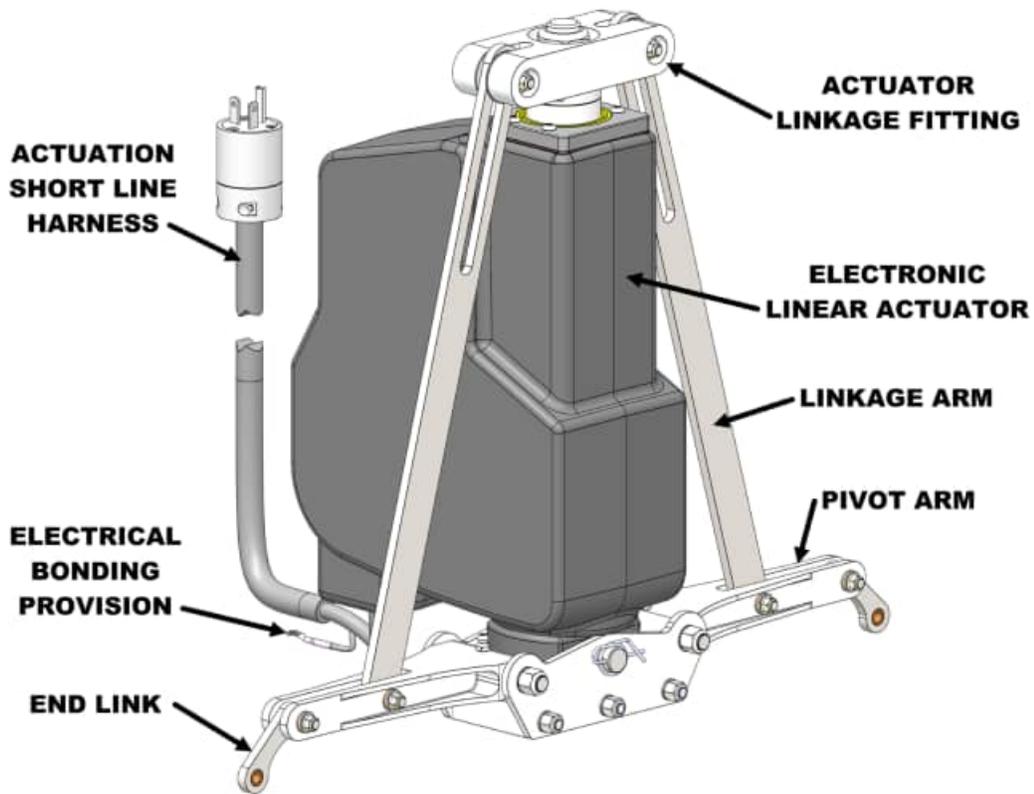


Figure 15: Actuation Assembly

The Actuation Assembly consists of an electronic linear actuator, an actuator linkage fitting, two linkage arms, two pivot arms, and two end links. The slots in the linkage arms allow the valve to open when the actuator is retracted. This allows water to flow into the bucket during dip filling. It also prevents debris from becoming trapped at the valve seal interface.

The actuation assembly is mounted on top of the pump mount plate, centered on the valve platform. The valve assembly connects using bolts that attach the end links to the clevis blocks on top of the valve. Electrical signals and power transmitted through the actuation short line harnesses control the actuator.

When in operation, the actuator draws up to 15A at 28VDC. The actuator has a built in current limiting function. In the event that the load on the actuator draws more than 28A, the actuator will lock out and stop functioning until it is reset. Resetting the actuator can be accomplished by releasing the switch in the cockpit that controls the actuator and then depressing it again to continue extending the actuator. Alternatively, pressing and releasing the switch will cause the actuator to retract.



*Bucket Refill Pump System*

When operating with shallow water sources, a powered pump is used to fill the bucket. Instead of dip-filling, operators using the bucket refill pump lower only the bottom of the bucket into as little as 15 inches of water and turn the pump on to fill the bucket to the desired level. The DC powered Kawak bucket refill pump system is nominally rated at a 725 gpm flow rate. In order to protect the bucket’s skin from contacting edges of the refill pump, a rubber bumper is mounted to the refill pump. Also, a snag shield is mounted to the refill pump to eliminate the risk of rigging ropes or electrical harnesses snagging on the pump assembly and causing damage.

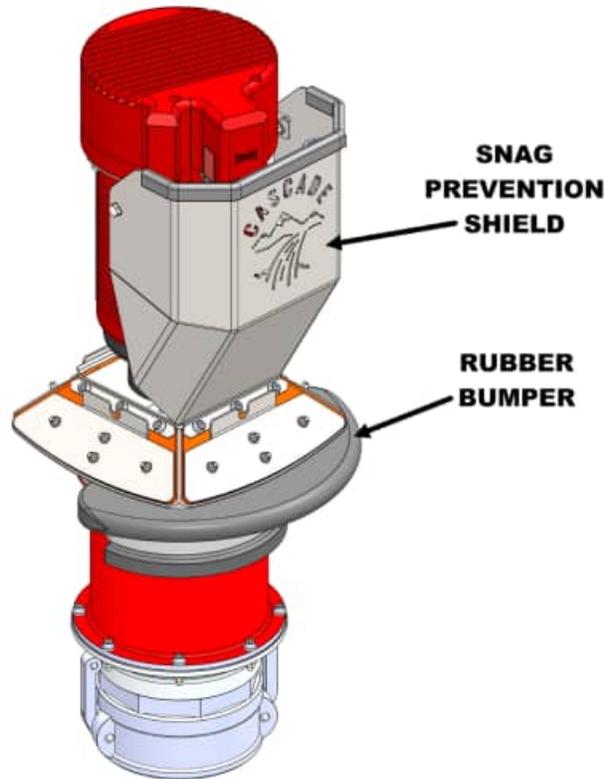


Figure 16: 28 VDC Bucket Refill Pump Assembly

Bucket Capacity	*Fill Time
260 gallon (984 liter)	22s
320 gallon (1,230 liter)	27s
350 gallon (1,325 liter)	29s

Table 3: Bucket Fill-Time

*\* Fill times vary depending on the motor’s current limit setting. Listed fill times are based on a 100A motor current setting with no long line. See Table 4 for more information.*



When water is pumped through the Bell Housing, the Check Valves are forced open. The rubber (fabric reinforced silicone) makes a hinge and the flange on the outer check valve plate limits the range of motion of the valve, so it is held at approximately horizontal.

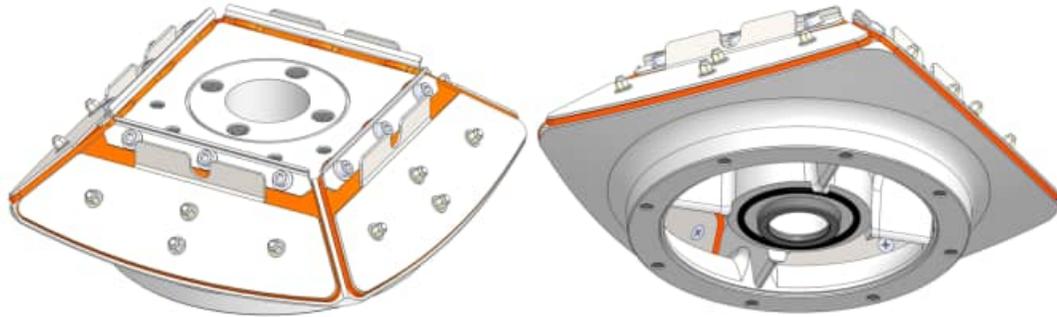


Figure 17: Bell Housing and Check Valves

The Impeller and Stator design is based off Kawak’s reliable hover refill pump. The motor spins the impeller which pumps water through the stator fins and out through the four check valves.

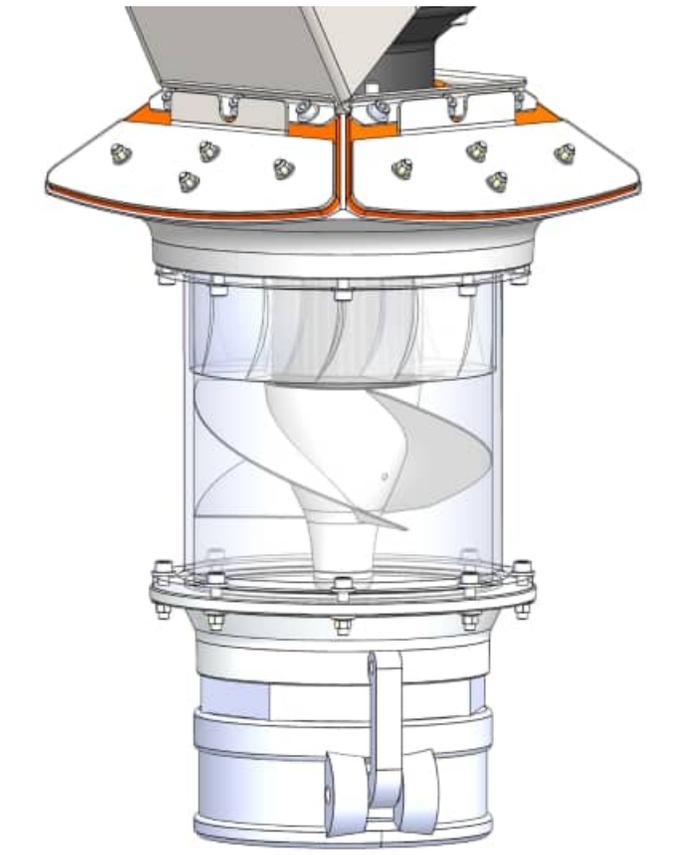


Figure 18: Impeller and Stator



The Cam and Groove mounting method allows for quick removal of the BRP (Bucket Refill Pump) assembly. This quick and robust form of mounting ensures that the BRP remains firmly mounted to the lower structure. For added safety, a hook and loop strap wraps around the cam levers to ensure the levers do not work loose during operation. The pump can be quickly removed and replaced with a cap if the BRP is not needed for a specific application.

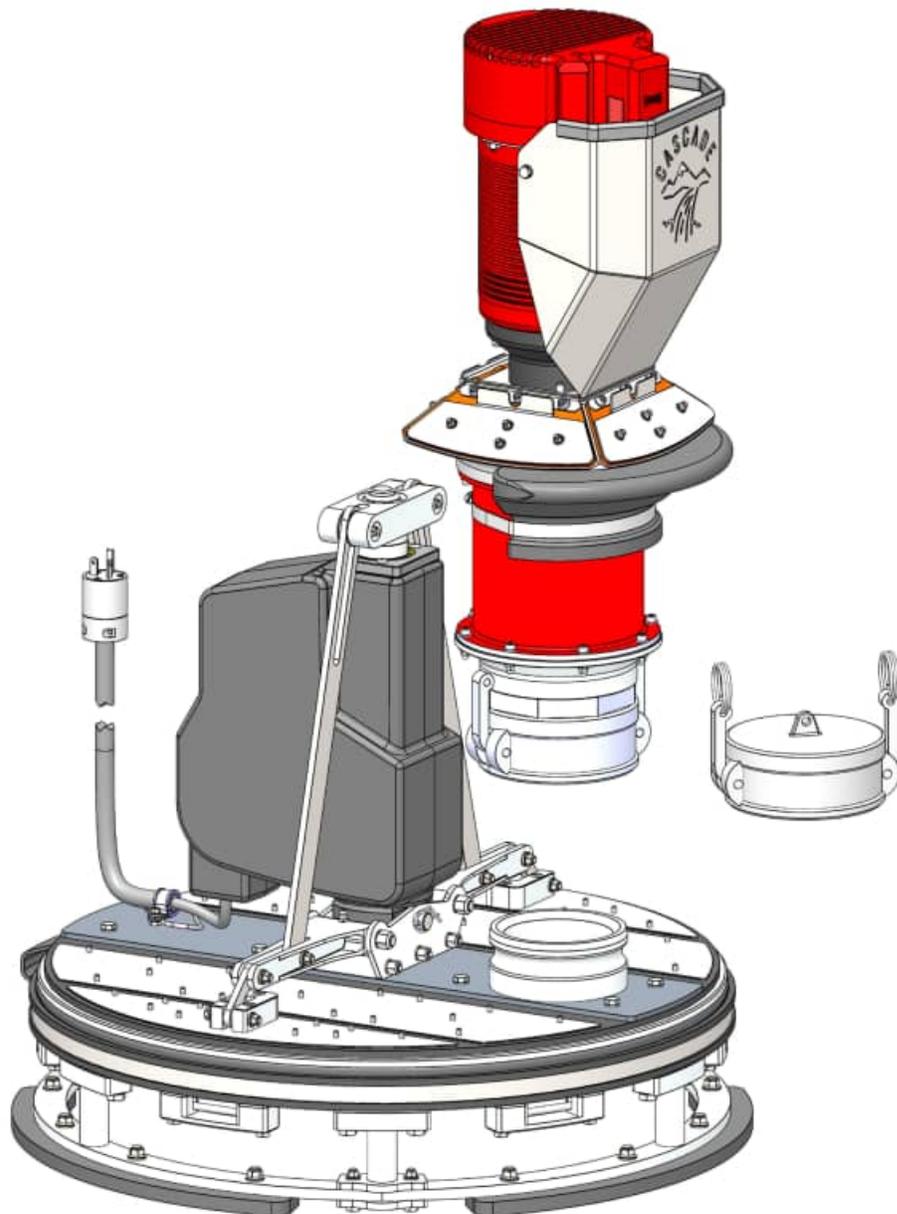


Figure 19: Cam & Groove Interface



*Wiring Harness Connection Points*

When operating with a refill pump, two wire harnesses come down from near the lifting plate, travel through separate zip-up short line sleeves, each containing a harnesses and a rigging rope. The harnesses then exit the sleeve and go around the outside of the inlet frame. The refill pump harness is mounted to a strap clamp plate with two 0.5" wide plastic cable ties and plastic cable tie mounts. The actuation harness is mounted to a strap clamp plate with two loom clamps. From there, they hang freely on the inside of the skin and terminate at the actuator and BRP. See Figure 20.

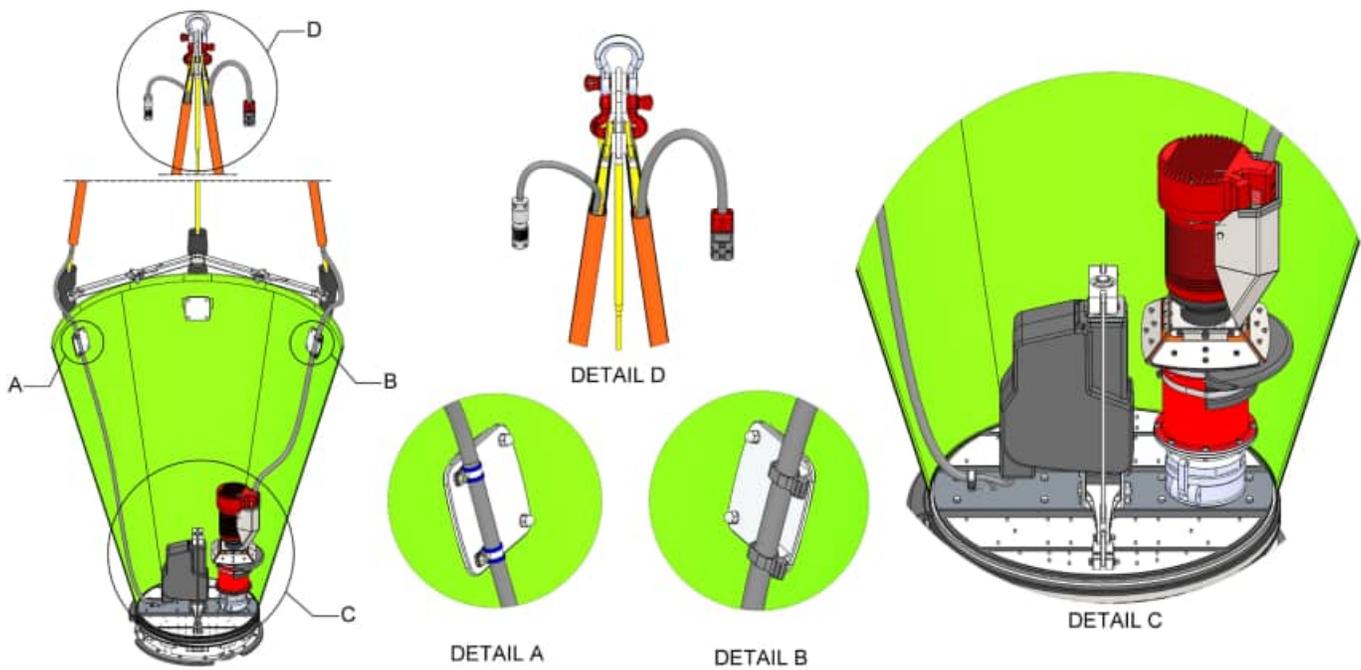


Figure 20: Electrical Harness Connection Points



## Section 5: INSTALLATION AND SET-UP

### Aircraft Modifications Required

Modifications required for an aircraft to operate the Cascade bucket are limited to electrical wiring. The Cascade bucket does not utilize a dedicated control panel. Instead, switches in the aircraft are dedicated to operating the bucket. It is the responsibility of the operator to build or procure a custom longline to connect the Cascade bucket electrical harnesses to the aircraft, and to configure existing switches in the aircraft for control of the submersible actuation system and optional bucket refill pump. Connection to aircraft power supply shall be made in accordance with FAA regulations, reference advisory circular AC43.13-1B and AC43.12-2A.

**⚠ WARNING:** Do not connect the Cascade bucket to any aircraft bus bar that is used for emergency or essential loads. Amend the aircraft electrical load analysis to ensure that the generator capacity is adequate to operate the system.

### Bucket Set-Up

#### Electrical Installation

The actuator can draw up to 15A at 28VDC depending on the load. A schematic for a typical bucket DC power installation using a momentary (spring-loaded) SPST switch is shown in Figure 22 below. It is the responsibility of the operator to wire the DC harness connector on the belly of the aircraft (J13) as shown. A photo of the Kawak supplied connectors installed on the short line are shown in Figure 21 below.

**ANDERSON**  
**2-7252G11**  
**(DC REFILL PUMP)**

**NEMA 5-20P**  
**(ACTUATION)**



Figure 21 Kawak Supplied Short Line Connectors, 28VDC Refill Pump

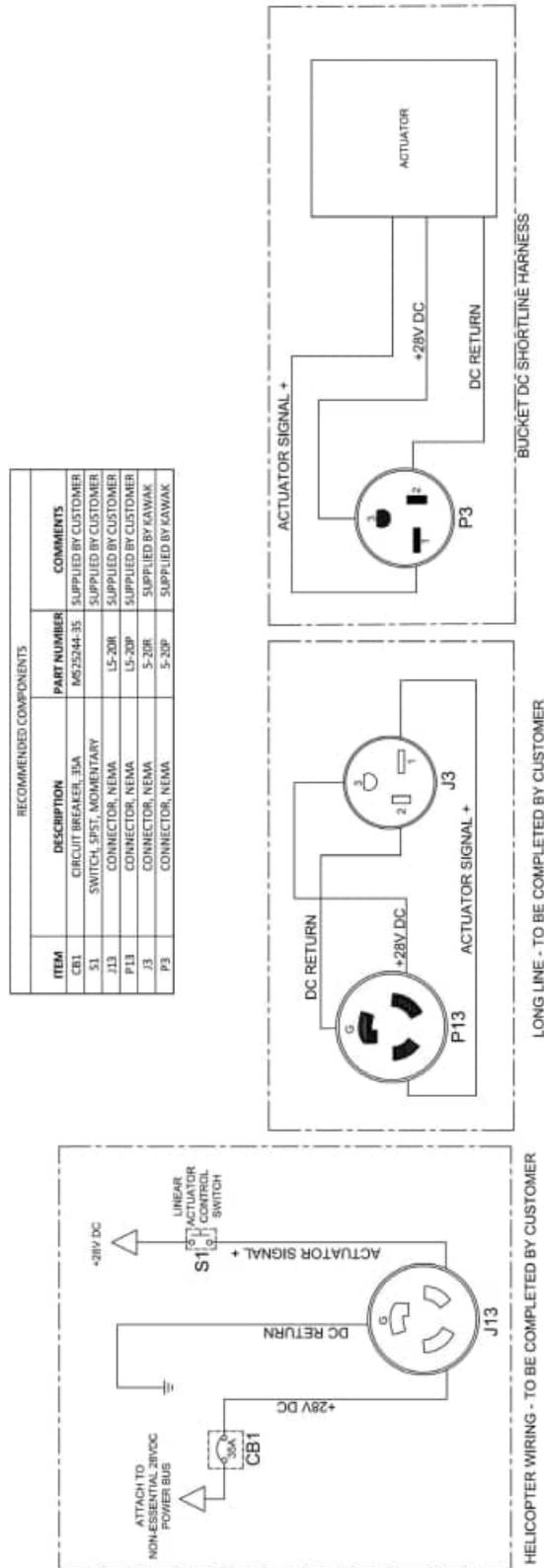


Figure 22: DC Wiring Schematic for the Cascade Bucket Valve Actuation



The 28VDC bucket refill pump requires 80A – 150A depending on desired performance and other variables. This DC pump motor’s current can be internally limited to 80A, 100A, 120A or 150A. The higher the current limit is set, the greater the fill rate will be. However, the wire gauge will also have to be increased as the current limit and long line length are increased. Table 4 below shows pump performance at different current settings and long line lengths. Refer to Figure 23 below for a schematic of a typical bucket refill pump installation. It is the responsibility of the operator to complete the wiring between the connector on the belly of the aircraft (J13) and a suitable DC power source.

Table 4 Estimated DC Pump Performance and Long Line Wire Gauge Table

Long Line Length	50'	Current Setting	Max. Wire Gauge	Est. Flow Rate (GPM)	Est. Line Weight (lb)
		80A	8 AWG	651	13.7
		100A	6 AWG	714	19.4
		120A	6 AWG	764	19.4
		150A	4 AWG	820	25.75
	100'	Current Setting	Max. Wire Gauge	Flow Rate (GPM)	Est. Line Weight (lb)
		80A	4 AWG	671	51.5
		100A	4 AWG	734	51.5
		120A	2 AWG	784	71.2
		150A	2 AWG	840	71.2
	150'	Current Setting	Max. Wire Gauge	Flow Rate (GPM)	Est. Line Weight (lb)
		80A	4 AWG	651	77.25
		100A	2 AWG	738	106.8
		120A	0 AWG	788	127.5
		150A	0 AWG	845	127.5
	200'	Current Setting	Max. Wire Gauge	Flow Rate (GPM)	Est. Line Weight (lb)
		80A	2 AWG	654	142.4
		100A	0 AWG	748	170
		120A	0 AWG	780	170
		150A	00 AWG	838	192

\*All minimum wire gauges maintain a voltage drop less than or equal to 8 volts (assuming a 28V supply)

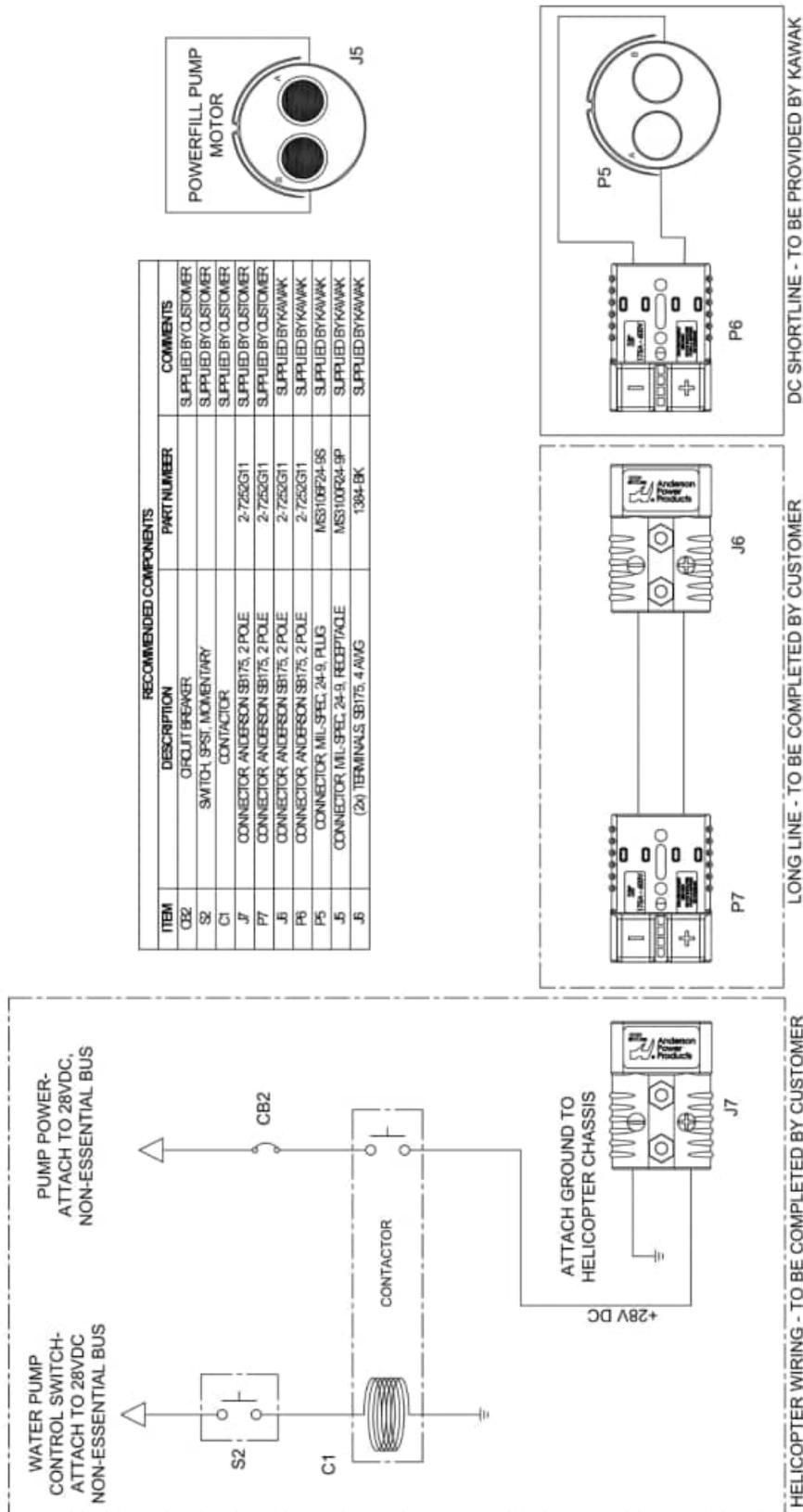


Figure 23: Wiring Schematic for 28VDC Bucket Refill Pump

**CAUTION:** Correct polarity must be confirmed prior to powering on 28VDC pump. Reversed polarity will cause irreparable damage to pump circuitry and will not be covered under warranty.



Recommended long line conductor wire gauges for the DC valve actuator are summarized in Table 5.

**\*\*NOTE:** Incorrect long line wire size will diminish system performance and can result in electrical shorts.

LONG LINE CONDUCTOR SIZES, ACTUATOR	
Line Length	DC Power, Actuator (260, 320, 350 BUCKETS)
50' & under	14 AWG
51' – 100'	12 AWG
101' – 150'	12 AWG
151' – 200'	10 AWG

Table 5: Long Line Conductor Size

When all helicopter-side DC actuator wiring has been completed, the polarity of power supplied to the bucket must be verified to be correct before connecting the DC harness to the actuation assembly.

**\*\*NOTE:** The actuator will not function if the polarity is incorrect. However, incorrect polarity will not result in damage to the actuator.

To check DC power polarity:

1. Confirm that the DC power source is turned off.
2. Connect the DC harness to the matching 30A connector on the long-line, leaving the bucket-side connector disconnected.
3. Connect the long line to the 30A NEMA connector on the belly of the aircraft or ground power cart.
4. Turn on the 28VDC power source.
5. Check the voltage between terminals 2 and 3 at the DC NEMA receptacle J3 using a DMM (Digital Multimeter) by connecting the positive probe to pin 3, and the negative probe to pin 2. If polarity is correct, the reading will be +24-28VDC at pin 3 with respect to pin 2.
6. If polarity is reversed, turn off DC power, pull the circuit breaker, and swap the wires to terminals 2 and 3 at the DC NEMA receptacle J3 at the end of the long line and re-test.

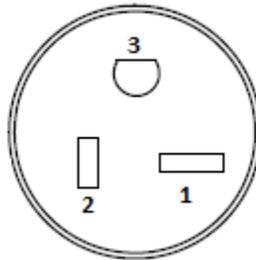


Figure 24: Mating Face of J3

**⚠ WARNING: INJURY RISK.** Failure to turn off DC power and pull the circuit breaker can result in electrical shock.

To check the actuator signal wire connection:

1. If not already completed, follow steps 1-6 in the previous section.
2. Check the voltage between terminals 1 and 2 at the DC NEMA receptacle J3 at the harness connector using a DMM by connecting the positive probe to terminal 1, and the negative probe to terminal 2. If the wiring is correct, the reading will be +24-28VDC at terminal 1 with respect to terminal 2 when the assigned actuator control switch in the cockpit is depressed. There should be no voltage across these pins when the switch is released.

After correct DC power polarity and actuator signal wiring has been confirmed:

- Turn off 28VDC power.
- Connect the DC harness to the actuator harness.

**⚠ WARNING: INJURY RISK.** There are multiple pinch points throughout the next few steps. Be mindful of where your hands and fingers are while initiating power to the linear actuator, as sudden movements may occur. It is recommended to have one person in charge of this operation and giving directions to help prevent injury.

3. Turn on DC power to test the actuator.
4. When the system is ready, test the function of the actuator by closing the switch in the cockpit to open the valve assembly.
5. Releasing the switch will cause the valve assembly to automatically close.
6. Repeat opening and closing the valve a couple times to verify normal function.



### Polarity Check for the 28 VDC Bucket Refill Pump

When the DC Refill Pump wiring is complete, it is necessary to check the polarity of the supplied DC power **BEFORE powering the pump**. To do this:

 **CAUTION:** Correct polarity must be confirmed prior to powering on 28VDC pump. Reversed polarity will cause irreparable damage to pump circuitry and will not be covered under warranty.

1. Disconnect the Anderson connector for the refill pump short line harness at the lift block so the pump cannot be powered on.
2. While one crew member closes the cockpit switch to power the refill pump circuit, the second person is needed to confirm correct polarity at the disconnected Anderson connector. Consult Figure 23. Polarity should match the (+) & (-) markings on the Anderson Connector.
  - a. If the second crewmember measures correct DC polarity, no wiring corrections are needed. Re-connect the Anderson connector at the lifting block. The pump can now be powered on and tested.
  - b. If the second crewmember measures reversed DC polarity, wiring corrections are needed.
    - i. To correct this, turn off DC power, pull the circuit breaker, and switch the two DC conductors at the connector at the belly of the aircraft.

 **WARNING:** INJURY RISK. Failure to turn off DC power and pull the circuit breaker can result in electrical shock.

3. If wiring corrections were made, confirm correct polarity before re-connecting the Anderson connector at the lifting block and powering and testing pump.

### Initial Receiving and Bucket Setup

Refer to the [Cascade Firefighting Bucket Basics](#) video on the [Cascade Fire Bucket](#) page on the Kawak website.

1. Loosen the straps and remove them.
2. Remove the cargo net and fold it for future use.
3. Lift the bucket off the pallet using a forklift and set it on the ground. Retain the pallet for future storage and transportation purposes.
4. Remove the straps around the bucket skin and extend the rigging ropes and electrical harnesses.



**CAUTION:** Take care not to twist or entangle the rigging ropes or electrical harness. This could cause hazardous lifting conditions and/or damage to the equipment.

**\*\*NOTE\*\*:** The straps hold the system in its compact form. The lifting block, rigging ropes and electrical harnesses will be coiled and secured to the top of the collapsible inlet frame or coiled within the bucket.



**WARNING:** PINCH POINTS. There are multiple pinch points throughout the next few steps. Be mindful of where your hands and fingers are while manipulating the collapsible inlet frame. It is recommended to have one person in charge of this operation and giving directions to help prevent injury.

5. Remove the quick release pins retained with lanyards from the hinge blocks on the frame arms to allow the inlet frame to expand to the open position.
6. Grab one of the two rigid (non-hinged) frame arms and pull it towards you away from the bucket.
7. Lock the hinge blocks in place with the quick release pins as the frame expands.
8. Lift the other rigid (non-hinged) frame arm out allowing the frame to fully expand and be locked in the open and operating position. Be mindful of pinch points for your fingers and the rigging ropes.

**\*\*NOTE\*\*:** With the frame expanded, the bucket will resemble a cup because of the internal battens installed in the strap pockets.

9. Complete a visual inspection of the various components, looking for anything that would cause an operational problem or hazard:
  - a. Check for any visible damage, wear, or tear on the bucket's exterior.
  - b. Ensure there are no cracks, dents, or deformities in the metal parts.
  - c. Examine the polyurethane-coated fabric for punctures, tears, or abrasions.
  - d. Inspect shackles, sling connectors, rope thimbles, and attachment hardware for damage.
  - e. Look for fraying, cuts, or abrasions on rigging ropes and lifting straps.
  - f. Check for proper operation of the valve assembly and refill pump check valves.

After reconciling any uncovered problems or issues, you are now ready to attach your Cascade Bucket System to the helicopter for deployment.



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## Section 6: OPERATING THE BUCKET

### System Operation

#### Product User Function and Interface

##### *Actuator Operation*

The Cascade bucket currently provides one mode of operation:

- Traditional dead-man operation using a SPST momentary switch

**Dead-Man Mode** is intended for executing multiple, partial bucket dumps per run.

- Depressing and holding the momentary switch opens the valve.
- Releasing the switch closes the valve.

**\*\*NOTE\*\***: The valve will not stay open unless the switch is held down.

**\*\*NOTE\*\***: In the event the current through the actuator exceeds the rated maximum during actuation, the actuator will lock out. To unlock it, simply release the momentary switch, then press and hold it again to keep the actuator extended. Alternatively, release the switch to retract the actuator.

##### *Bucket Refill Pump Operation*

When the bucket refill pump is employed with the bucket, an SPST momentary switch is utilized to control the pump motor. The operation of the bucket refill pump is similar to the operation of the valve.

- Depressing and holding the momentary switch powers the motor to fill the bucket and releasing the switch cuts power to the motor.

**\*\*NOTE\*\***: The bucket can be completely or partially filled depending on the length of time for which the switch is depressed. Refer to Figure 25 for the recommended installation of the Bucket refill pump electrical connections.

#### Deploying the Bucket

To deploy the Cascade Bucket System:

1. Follow the steps outlined in the Initial Receiving and Bucket Setup section to prepare the bucket for use.
2. Connect the harnesses to the longline and secure them in place.

Perform the normal pre-flight check procedure (see Pre-Flight Check Procedure below)



### Collapsing the Bucket

When preparing to collapse the bucket, start with the lower structure sitting upright on the ground surrounded by the inlet frame. To collapse the inlet frame:

1. Pull the quick release pins with lanyards attached to them.
- ⚠ **WARNING:** PINCH POINTS. There are multiple pinch points throughout the next few steps. Be mindful of where your hands and fingers are while manipulating the collapsible inlet frame. It is recommended to have one person in charge of this operation and giving directions to help prevent injury.
2. Push the hinge blocks towards the center while pushing the solid frame members closer to each other.
3. Continue pushing the solid frame members until the frame collapses.
4. Install quick release pins if desired to secure the hinge blocks together. A tiedown can be placed around the inlet frame to keep it lightly stowed.
5. Place a strap around the circumference of the bucket, if desired, to gather the skin pleats and make the stowed bucket more compact.
6. Coil rigging ropes and harnesses and place them on top of the collapsed inlet frame along with the lifting block. Alternatively, the rigging ropes, harnesses and lifting block can be stowed within the bucket to decrease overall height.



Figure 25: Collapsed Inlet Frame



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### Pre-Flight Check

Along with the aircraft, the bucket requires daily pre-flight inspection to ensure safe and trouble-free operation.

Beginning at the bottom of the aircraft:

- Inspect the cargo hook and main screw pin shackle for solid attachment and signs of wear.
- Inspect the electrical connectors for a positive and secured connection. Make sure there is enough slack to prevent unwanted tension on the connection.
- Inspect the long line and cables for rips and tears down to the lifting block of the bucket.
- Inspect the shackles connected to the lift block. Check for excessive wear and see that the connections are properly secured with tape or safety wire.
- Inspect the NEMA cable connections at the lifting block for a solid positive connection and that a proper service loop is used to prevent tension on the NEMA connectors.
- Inspect the rigging ropes and sling connectors at the inlet frame for signs of excessive wear or fraying of the ropes.
- Inspect the power cables for cuts or heavy scrapes with extra focus on where they interface with the inlet frame.
- Inspect the inlet frame. Look for cracks or breaks. Check that all the quick release pins are in place and operating properly, holding the frame in the open position.
- Inspect the lift straps and strap clamp fittings. Ensure all hardware is present and properly torqued. Check for wear and fraying of the straps in the exposed areas and on the back of the strap where it contacts the Strap Clamp Fitting.
- Ensure the area between the lifting strap and strap clamp fitting is clean and free of excessive grit. Keeping this area clean and free of abrasive materials will significantly increase lifting strap service life.
- Inspect the skin for rips, tears, UV degradation, seam separation/fraying/wear, and excessive wear points. Repair, as necessary.
- Inspect the attachment of the skin to the valve base. Ensure the T-bolt clamp is positioned correctly around the sealing surface and is properly torqued to maintain the seal and prevent leakage.
- Inspect the lifting strap attachments to the valve base. Check that all hardware is present and properly torqued.
- Inspect the inlet screen for damage and remove any stuck debris to ensure proper waterflow while power fill operation is occurring.
- Inspect the electrical connections at the bucket refill pump. Ensure that proper slack is present, and the connectors are tight, to prevent unwanted water ingress.
- Inspect the four (4) check valves on the bucket refill pump. Clear any debris and check that all hardware is present and properly torqued.



- Ensure that the cam and groove attachment point on the bucket refill pump (or cap) is secure and solid, and that the hook and loop strap is fastened around the cams, to prevent an accidental disconnection from the valve base.
- Inspect the actuation assembly. Check for signs of excess wear on the moving components. Check that all hardware is present and properly torqued.
- Inspect the valve assembly for any cracks or tears or bends in the hinge plates which could cause a poor seal to the base.

After a thorough visual inspection and repair of problems found, test the operating systems of the bucket.

- Have the pilot operate the bucket refill pump. A hum can be heard or felt if it is functioning.
  - Listen or feel for excess vibrations or sounds that would constitute rough operation. Hold a hand near the cast outlet and check valves. If air can be felt coming through the valves, the pump is working properly.

**WARNING:** INJURY RISK. Do not insert hands, fingers, or objects into the pump outlets while power is connected to the bucket refill pump. Contact with the spinning impeller could result in injury to hands or fingers.

- Have the pilot extend and retract the actuator.
  - Watch for smooth and fluid operation.

### Lifting the Bucket

The Cascade bucket should be lifted off the ground with the helicopter directly overhead to avoid inducing an unintentional and unwanted swinging or dragging of the load.

### In-Flight Operation

The Cascade bucket does not display a tendency to spin while in flight. With most of the weight concentrated down low, its flight characteristics are very stable.

### Filling and Dumping

#### *Filling*

The unique design of the valve assembly with its attachment to the actuator allows the Cascade bucket to be filled more efficiently than other systems. Because of this design, the Cascade bucket can be filled by simply lowering it into the water source. The valve assembly will automatically open to allow water to fill the bucket from the bottom. If outfitted with the bucket refill pump, turning on the pump (depress and



hold the switch) as the bucket is being lowered into the dip site will cause it to rapidly sink and fill with water. As the bucket is lifted out of the water, the valve assembly will automatically close without any operation from the pilot.

**\*\*NOTE\*\***: The Cascade bucket was designed to be lowered straight down into the water source for filling. Attempting to tip the bucket on its side to get it to sink is not necessary or encouraged.

Filling the bucket, using the bucket refill pump, is accomplished by pressing and holding the user-configured switch. Releasing the switch will shut off the pump. This is covered in more detail under the Bucket Refill Pump Operation heading at the beginning of this section.

#### *Dumping*

Dumping the water load is accomplished by pressing and holding the user-configured switch. Releasing the switch will close the valve. Split drops are controlled manually, with no limit on the number of splits. This is covered in more detail under the Actuator Operation heading at the beginning of this section.

## Section 7: MAINTENANCE AND REPAIRS

### Maintenance Procedures

#### General Maintenance

The Cascade bucket has been designed to minimize required maintenance. Daily maintenance activity is limited to completing a post-flight inspection for damage, washing down the bucket at the end of each day of use with fresh water, and allowing it to dry before collapsing for storage or transportation.

#### *Post-Flight Procedures*

- At the end of each day of use, rinse the bucket with fresh water. Allow it to dry before collapsing the bucket.
- Inspect the rigging ropes for damage (cuts, abrasion, fraying, discoloration, melting, etc.). Replace, as needed.
- Inspect the lift straps for damage (cuts, abrasion, fraying, discoloration, melting, etc.). Replace, as needed.
- Check for any broken battens. Replace, as needed.
- Inspect the skin for any damage (abrasion, punctures, or tears). Repair as needed.



- Inspect the knuckle covers for wear. Replace as needed.
- Inspect the wire harnesses and connectors for damage. Repair or replace as needed.

#### Servicing the Actuator Assembly

The actuator assembly is not meant to be disassembled or serviced. Any non-resolvable issues with the actuator assembly necessitate its complete replacement.

If the actuator assembly is removed and replaced, electrical bonding between the actuator and the valve base assembly must be reestablished as the harness and actuator are permanently attached to one another. See Figure 26 below. Using a milliohm meter, measure resistance between the vertical blade of the actuator connector, P3, contactor 2, and the standoff or valve base of the bucket assembly. Resistance should not exceed 20 milliohms. If a milliohm meter is not available, measure the resistance with a multimeter. The resistance must be less than 1 ohm.

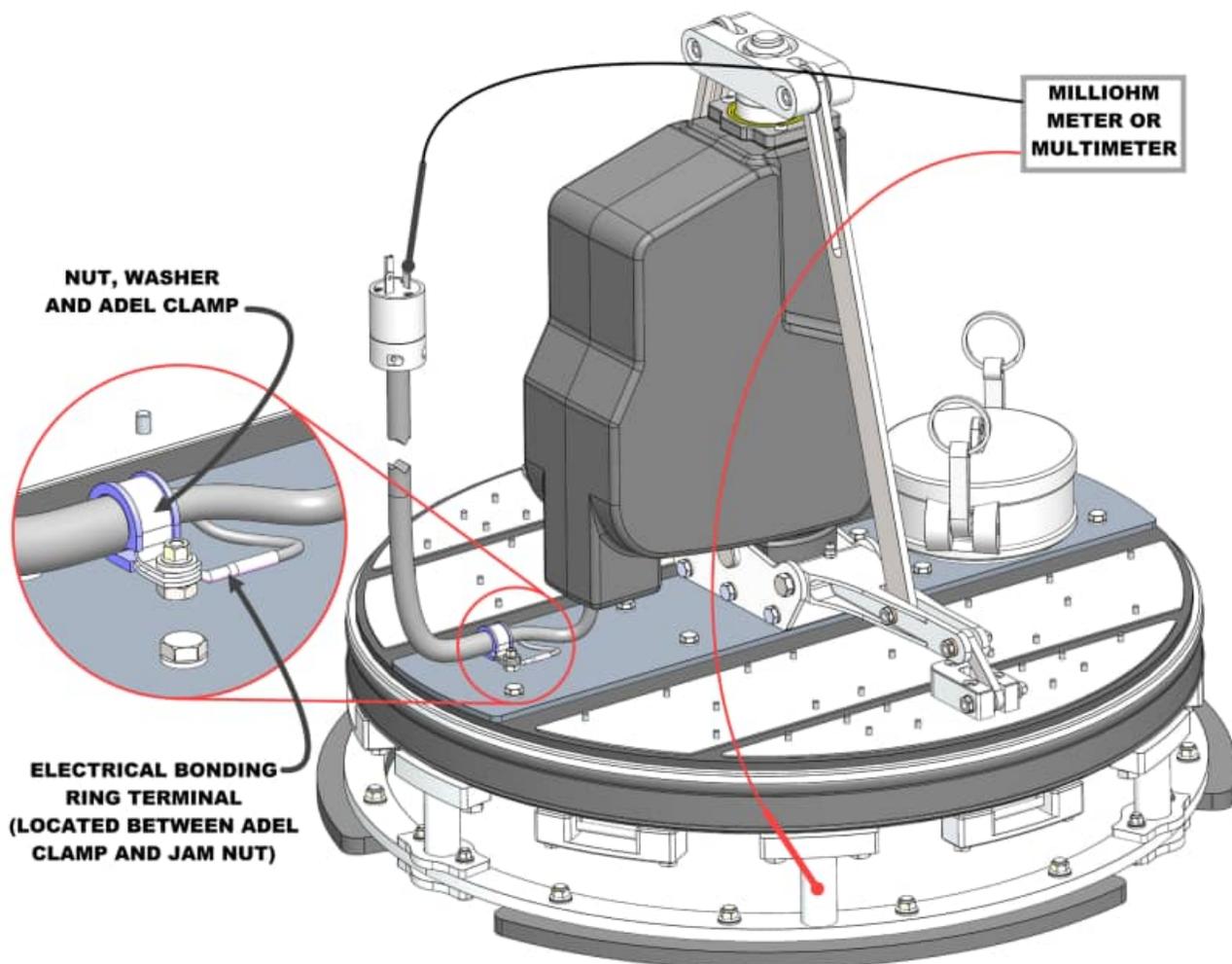


Figure 26 Linear Actuator Electrical Bonding (Bucket Skin hidden for clarity)



### Servicing the Bucket Refill Pump

**\*\*NOTE\*\***: It is recommended that all bearings, seals and O-rings be replaced during annual or preventive maintenance, or prior to long term storage for optimum performance of the Bucket Refill Pump.

#### *28VDC Bucket Refill Pump Disassembly*

1. Motor Removal (see Figure 27)
  - a. Remove the snag shield (KCB-0000-6001-00) from the pump assembly. Set the snag shield and hardware aside for reuse.
  - b. Disconnect the pump short line harness from the motor.
  - c. Remove the four socket head cap screws and lock washers securing the motor to the motor mount. Set them aside for reuse.

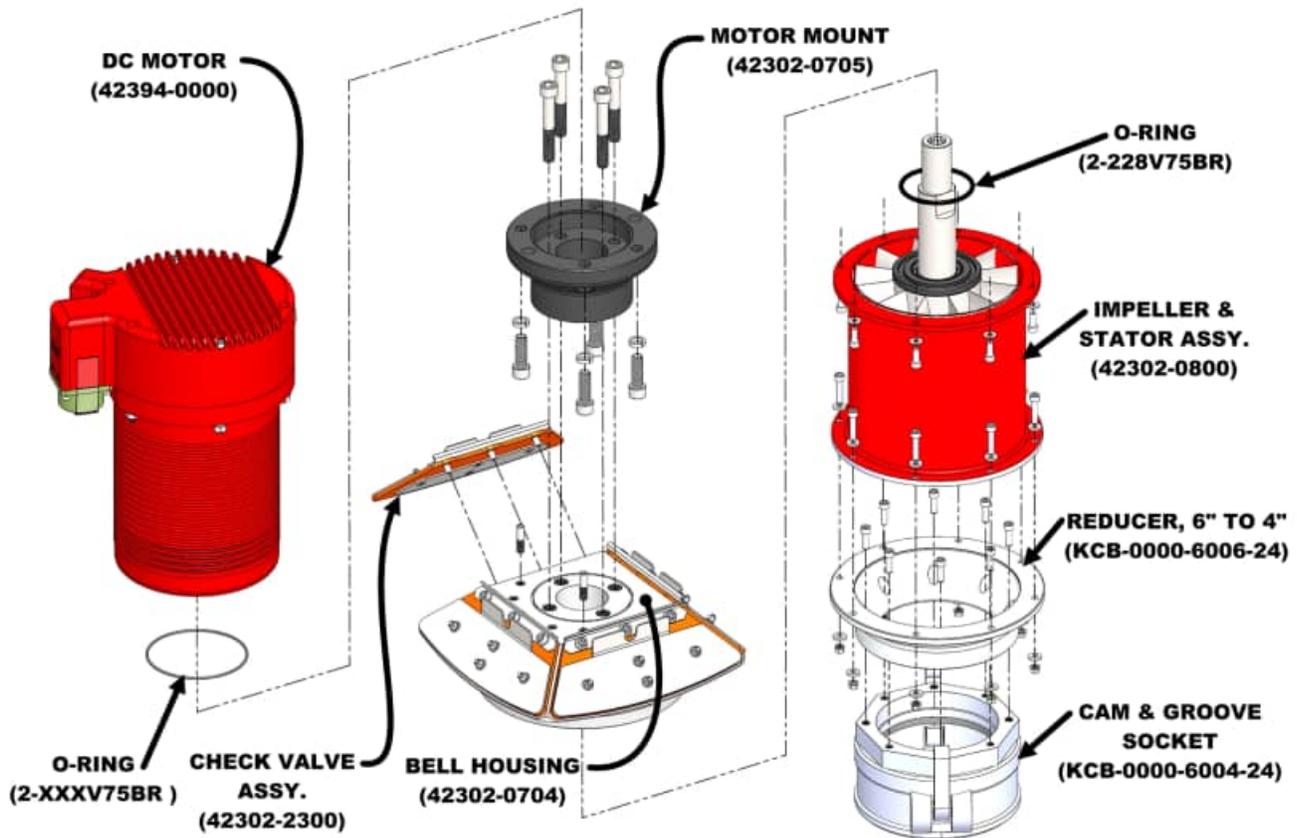


Figure 27: Bucket Refill Pump Disassembly (Motor Guard hidden for clarity)

2. Pump & Stator Disassembly (see Figure 27 and Figure 28)
  - a. Remove the bell housing and reducer from the impeller & stator assembly.



- b. Grasp the impeller shaft (42302-0802) and remove the socket head bolt on the impeller end of the shaft. If necessary to loosen the bolt, clamp the wrench flats of the Impeller Shaft in a vise with non-marring jaws.
- c. Remove the lock washer, impeller retaining plug (38420-1), and impeller (38418-1).
- d. Remove the spacer (42302-0803), shaft seal sleeve (38415-1) and O-rings from the shaft.
- e. From the inlet end of the stator, remove the shaft seal (152062TSS) and the retaining ring (99142A592).
- f. From the outlet end of the stator, remove the shaft seal (12162TSS).
- g. Slide the impeller shaft out of the stator assembly. The two bearings (SS6205-2RSH) and spacer (38416-1) should remain on the impeller shaft.
- h. Remove the two bearings (SS6205-2RSH) and spacer (38416-1) from the impeller shaft.

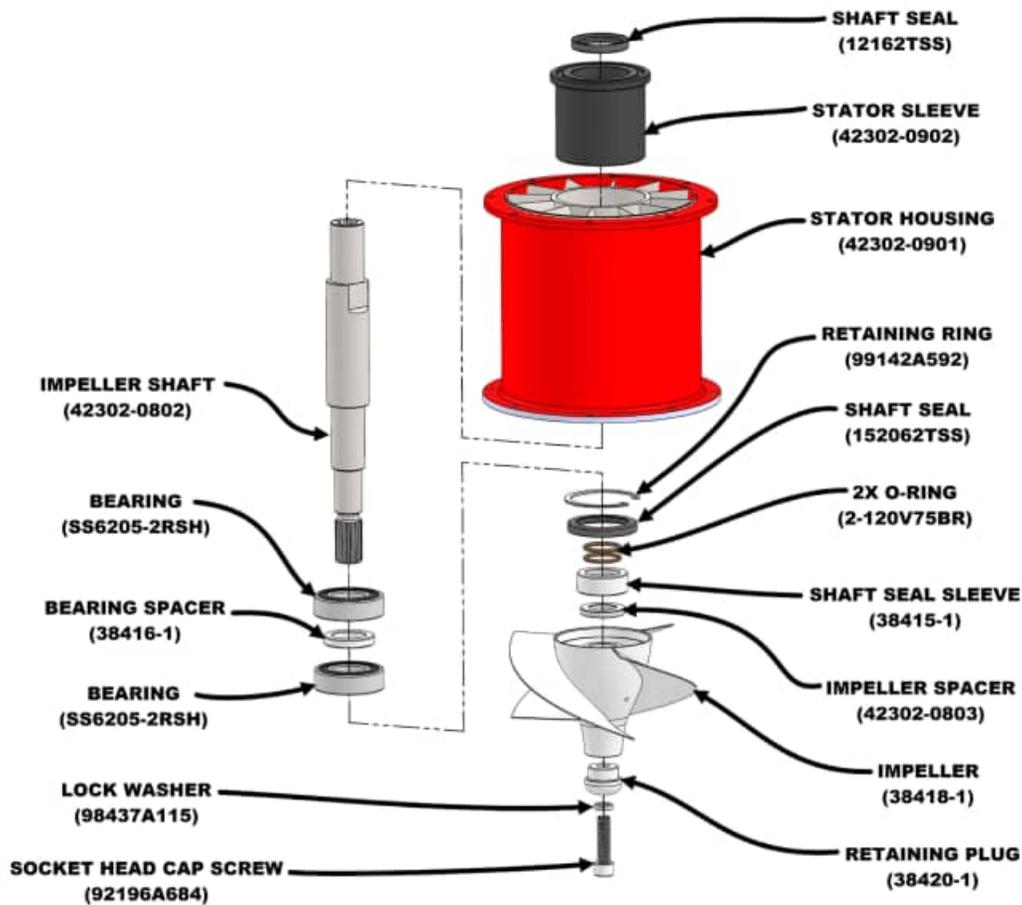


Figure 28: Impeller and Stator Assembly



3. Check Valve(s) Disassembly (see Figure 29)
  - a. Remove the three bolts, washers, clamp plate, and aluminum spacers securing each of the four check valve assemblies (42302-2300) to the bell housing (42302-0704).
  - b. Remove the four screws, washers, and nuts holding each check valve assembly together.

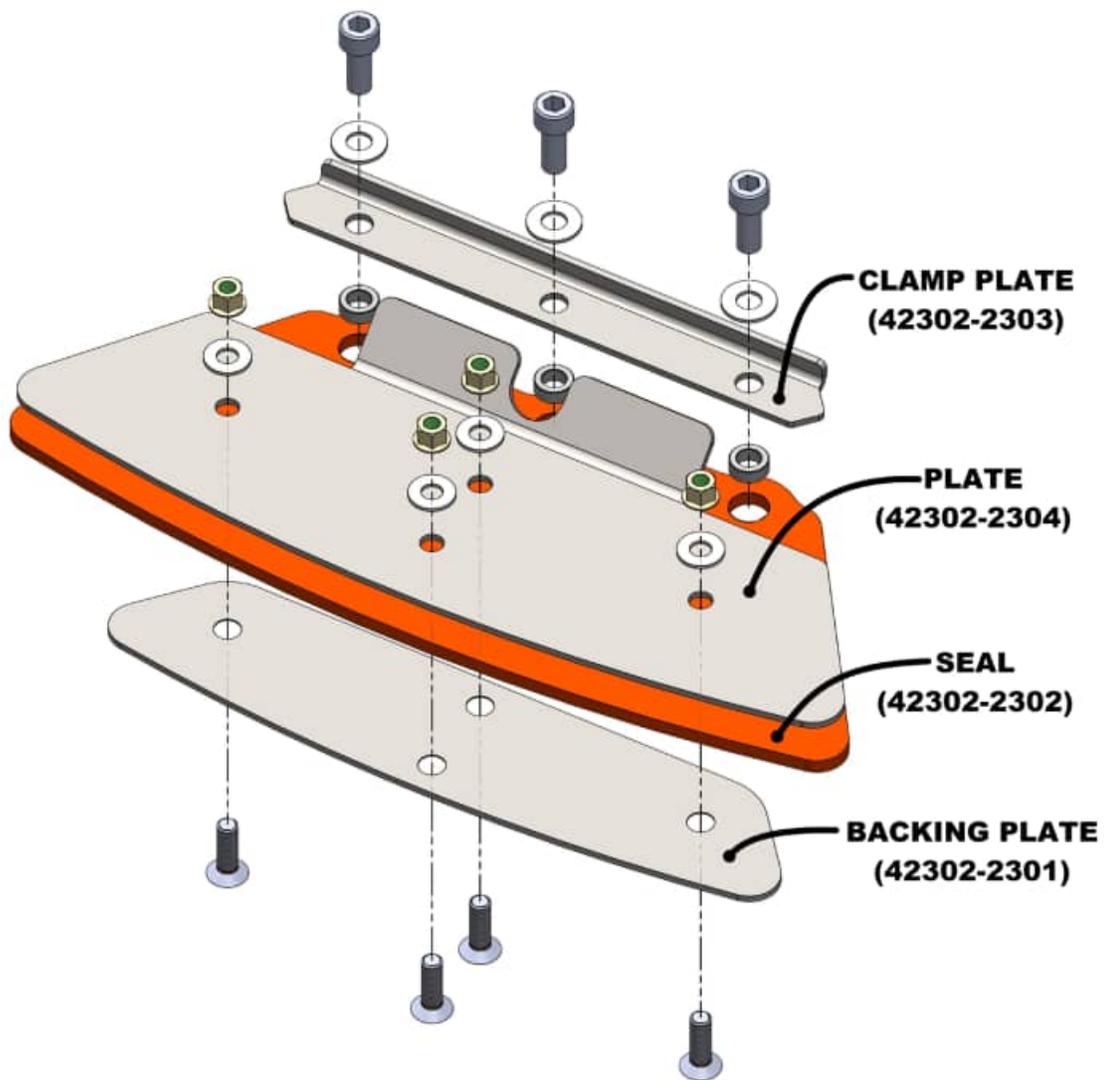


Figure 29: Check Valve Assembly



*Pump Assembly Inspection*

**\*\*NOTE\*\***: Prior to inspection, it is important to clean all parts that will not be replaced upon reassembly. Pay particular attention to cleaning anaerobic sealant residue from inside the stator sleeve and bell housing/stator sleeve interface.

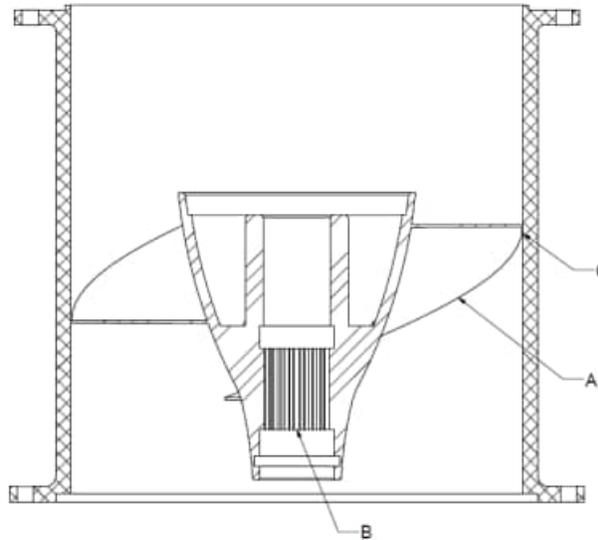


Figure 30: Impeller Inspection Points/Areas

Table 6: Impeller Wear/Damage Limits

Wear/Damage Limits: Impeller, Modified, P/N 38418-1			
AREA	TYPE OF DAMAGE	MAXIMUM DAMAGE/WEAR LIMIT	REPAIR
A	Mechanical, Impeller Blade	Gouges, dings, or damage Significantly degrading pump performance or impeller balance	Replace
B	Mechanical, Spline teeth	0.005" depth on driving face of spline teeth	Replace Superficial corrosion may be removed using fine steel wool.
C	Wear Clearance	If the clearance between the impeller and the stator housing exceeds .015"	Replace

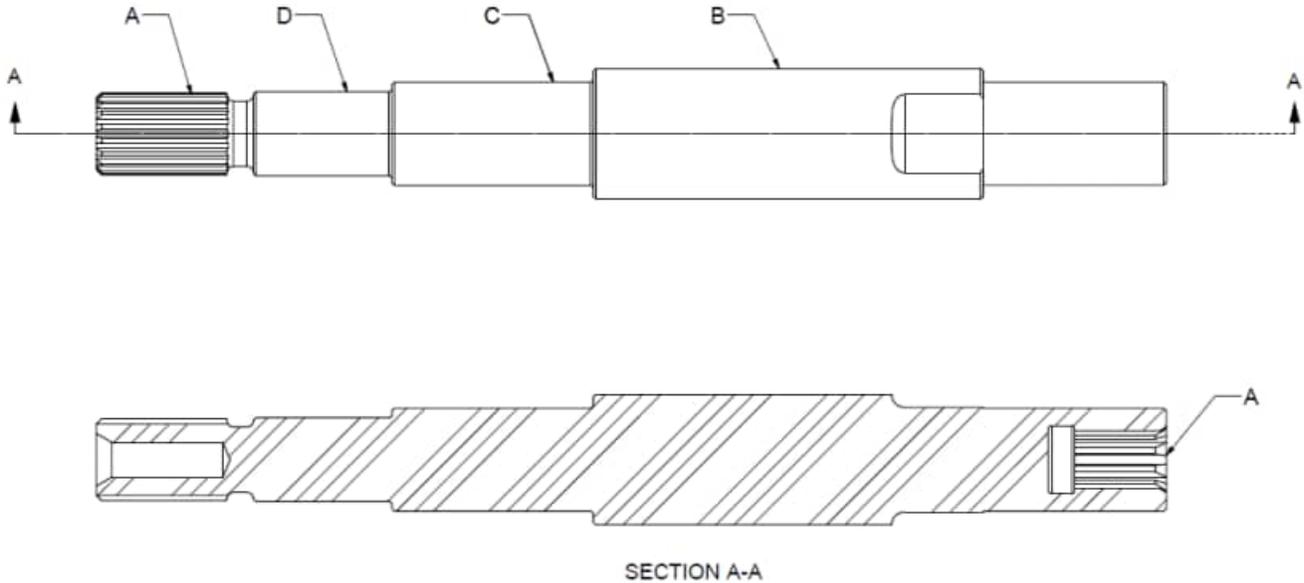


Figure 31: Impeller Drive Shaft Inspection Points/Areas

Table 7: Impeller Shaft Wear/Damage Limits

Wear/Damage Limits: Shaft, Impeller Drive, 38419-1			
AREA	TYPE OF DAMAGE	MAXIMUM DAMAGE/WEAR LIMIT	REPAIR
A	Mechanical, Spline Teeth	.005" depth on driving face of spline teeth	Replace Superficial corrosion may be removed using fine steel wool.
B	Mechanical, Seal Surface	Any scratches, dents, or grooves that would preclude proper sealing	Replace Light Polishing is permissible
C	Mechanical, Bearing Mounting Surface	Less than 0.9838" diameter or any damage that would preclude proper mounting and alignment of the bearings	Replace Light Polishing is permissible
D	Mechanical, Bearing Mounting Surface	Less than 0.795" diameter or any damage that would preclude proper mounting and alignment of the impeller	Replace Light Polishing is permissible



### *Bell Housing and Check Valve Inspection*

Inspect sealing edges of Bell Housing for damage i.e. bent lip, gouges, etc. Minor Damage that will still allow check valves to seal is acceptable and should be addressed to smooth burrs and gouges. Areas of deformation that do not allow check valves to close fully require replacement of Bell Housing.

Inspect the check valve seals for tears, cracking, or abrasion where the valves contact the sealing surfaces on the Bell Housing, and where the seals flex when the valves open and close. Inspect the check valve plates for bends or cracks. Replace any check valve parts with damage that would prevent proper sealing.

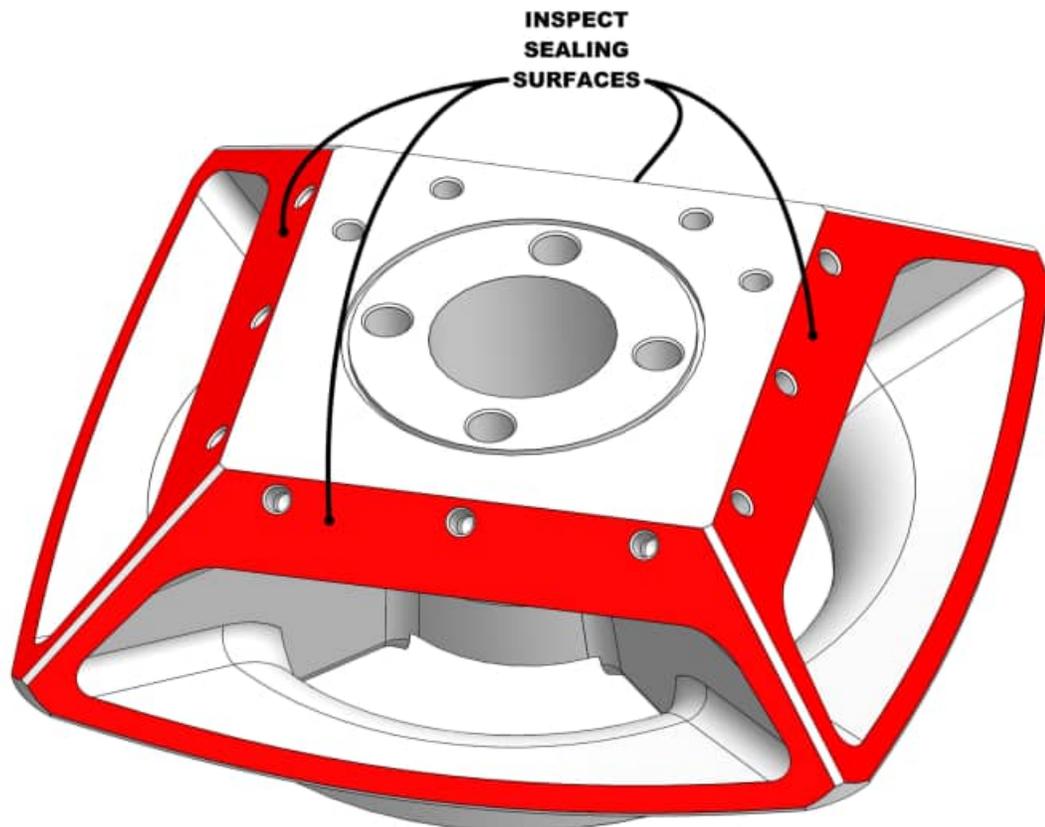


Figure 32: Check Valve Sealing Surface Inspection

### *Bucket Refill Pump Assembly*

#### 1. Pump Impeller and Stator Assembly

**\*\*NOTE\*\***: Ensure the inner diameter of bearing and seal area is clean, and no traces of grease or sealant remain prior to assembly.

**\*\*NOTE\*\***: Clean shaft seal sleeve thoroughly with isopropyl alcohol or other non-residue solvent prior to installation of the O-rings.

- a. Install the bearings (SS6205-2RSH) on the impeller shaft (42302-0802) placing the spacer (38416-1) between the two bearings.



- b. Apply a thin bead of a medium strength anaerobic sealant (e.g. Loctite 518) to OD of shaft seal (12162TSS)
- c. Install the shaft seal in the outlet side of the stator sleeve with the open side of the seal facing up (see Figure 32).
- d. Apply a thin layer of grease to the indicated (orange) lip area of the seal.



Figure 33: Seal Orientation and Grease Location

**\*\*NOTE\*\***: For the next step, cooling the impeller shaft/bearings assembly and warming the stator housing assembly is recommended to facilitate easier assembly. The interface between the bearings and stator is designed to be a very precise slip fit.

- e. Install the impeller shaft/bearing assembly into the stator by inserting the large OD (Outer Diameter) end of the impeller shaft up through the inlet side of the stator.
- f. Install the retaining ring (991142A592) to secure the impeller shaft/bearings into the stator.
- g. Apply a thin bead of a medium strength anaerobic sealant (e.g. Loctite 518) to OD of Shaft seal (152062TSS) and install it in stator housing with the open side of the seal facing outward. Apply a thin layer of grease to the lip area of the seal.
- h. Install the O-rings (2-119V75BR), **WITHOUT GREASE**, into the groove in the ID (Inner Diameter) of the shaft seal sleeve (38415-1) and install the shaft seal sleeve in the seal installed in step 3. Isopropyl alcohol can be substituted in place of lubricant to assist installation of the shaft seal sleeve onto the Impeller Shaft.

**\*\*CAUTION\*\*** It is important that these O-rings not be lubricated as the shaft seal sleeve (38415-1) **MUST** rotate inside the Shaft Seal (152062TSS) instead of the shaft (42302-0802) rotating inside the O-rings (2-119V75BR).



Failure to follow this instruction will cause premature wear on the O-rings and cause a leak to develop.

- i. Clamp the impeller shaft in a vise with non-marring jaws by the wrench flats on the shaft.
  - j. Install the spacer (42302-0803) onto the impeller shaft.
  - k. Apply grease (e.g. MIL-PRF-81322) to the external splines of the impeller shaft and to the internal splines of the Impeller.
  - l. Install the impeller (38418-1), making sure the splines engage smoothly, and the impeller slides in until it presses on the spacer (42302-0803).
  - m. Install the retaining plug (38420-1), lock washer and socket head cap screw using anti-seize lubricant on the threads.
  - n. Torque the socket head cap screw to 250 in-lbs.
2. Pump Assembly
- a. Place the stator assembly inlet down, so the shaft end is pointing up.
  - b. Install the O-ring (2-228V75BR) using silicone O-ring lube or petroleum jelly to avoid damage to the O-ring during installation.
  - c. Install the bell housing assembly (42302-0704) and the motor mount (42302-0705) onto the stator. Use RTV sealant to seal this interface.
  - d. Apply grease (MIL-PRF-81322) to the internal splines of the impeller shaft and the external splines of the motor shaft (42394-0000).
  - e. Install the O-ring (2-042V75BR) on the motor mounting flange pilot using silicone O-ring lube or petroleum jelly to avoid damage to the O-ring during installation.
  - f. Install the motor onto the motor mount, making sure the motor splines engage smoothly with the shaft impeller shaft splines.
  - g. Fasten the motor in place using the four socket head bolts and lock washers.
  - h. Connect the pump short line harness to the pump motor. Use a small amount of RTV sealant on connector threads when installing connector. This serves as a non-permanent thread locking provision.
  - i. Install the motor guard (KCB-0000-6001-00) using the hex head bolts, washers and nuts.



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## Bucket Skin Repair

Minor abrasions to the coating of the bucket skin material, as well as pinholes in the bucket skin, can be fixed using only glue. Repairing larger holes and damage to the underlying fabric requires a patch in addition to glue, or a heat-adhered patch.

 **WARNING:** Work in a well-ventilated area when performing repairs using glue or a hot air gun.

### Tools and Materials Needed:

- PVC Patch Cement for glue repairs
- Isopropyl alcohol, acetone, or similar solvent
- Abrasive pad (e.g., ScotchBrite) or 220-grit sandpaper
- Nitrile shop gloves
- Skin patches
- Scissors
- Hand-held roller
- Hot air gun with slit nozzle for heat-patched repairs

#### Glue-only repairs

1. Scrub the damaged area with an abrasive pad (e.g., ScotchBrite) or 220-grit sandpaper.
2. Clean with alcohol. Ensure that the damaged area is completely dry, and has a dull, matte appearance before proceeding.
3. Spread a liberal amount of glue over the damaged area with fingers (wear nitrile shop gloves if available/desired) or a brush. **\*\*NOTE\*\*:** The glue should cover an area that extends one inch beyond the edges of the damaged area in every direction, and two coats should be used.
4. The second coat should be applied within four hours of the first coat.
5. Allow the glue to cure for at least 24 hours at room temperature before using the bucket.
6. Keep the cement container tightly closed when not in use.

#### Glue Patch Repairs

1. Trim off any loose pieces of coating or fabric around the damage area with scissors.
2. Place the damaged area of the bucket skin on a flat, solid surface (e.g., concrete floor), or place a flat, solid object underneath the damaged area to support the skin.
3. Scrub the damaged area with an abrasive pad (e.g. ScotchBrite) or 220-grit sandpaper.
4. Wipe the area clean with a rag and alcohol.



5. When patching a hole, place a piece of masking tape on the side opposite the side of the skin that is to be patched. **\*\*NOTE\*\***: Ensure that the damaged area is completely dry, and has a dull, matte appearance before proceeding.
6. Cut out a patch that will extend at least two inches beyond the damaged area in every direction. **\*\*NOTE\*\***: Aim for the patch to be circular, or rectangular with rounded corners.
7. Scrub and clean both sides of the patch using the same method as in steps 3 and 4.
8. Apply glue to one side of the patch as well as the damaged area on the bucket skin. If the application instructions for the glue dictate, wait the prescribed amount of time before applying the patch to the damaged area.
9. Place the center of the patch onto the damaged area.
10. Lay the rest of the patch down, working outwards from the center.
11. If the work surface or supporting object underneath the skin is significantly sloped, tape the patch down using masking tape to ensure the patch does not slide away from the damaged area.
12. Using a roller, apply pressure to the center of the patch.
13. Roll outwards toward the edges in every direction to force any air bubbles out. **\*\*NOTE\*\***: Ensure that the patch does not lift once it has been placed. Maintaining full contact of the patch with the damaged area creates the strongest possible bond between the patch and the skin.
14. Place a plastic sheet over the patched area.
15. Weigh down the patch with a flat, heavy object for 12 hours at room temperature. **\*\*NOTE\*\***: After 12 hours have elapsed, the skin can be moved, but the bucket should not be used until the glue has cured for at least 24 hours.
16. Keep the cement container tightly closed when not in use.

#### Hot Air Patch Repairs

1. Follow steps 1-7 of the preceding Glue Patch Repair procedure.
2. Turn the hot air gun on, and let it warm up. Adjust the temperature as needed while adhering the patch. If a hot air gun with a temperature display/setter is used, set the temperature between 750-1000°F (400-550°C).
3. Place the patch on the damaged area while holding half of the patch partly folded up.
4. Heat the patch and the bucket skin between the two surfaces, starting at the center and working towards the edges. Keep the nozzle between 0.25" and 0.5" (0.6cm and 1.2cm) away from the surface.
5. Apply light pressure with the roller as the coating starts to melt (small bubbles will start to appear within seconds as the coating melts).
6. Continue to heat the patch and bucket skin and roll it simultaneously until the entire patch has adhered to the bucket skin.
7. Allow the patched area to cool down completely.



8. Attempt to peel back the edges and corners of the patch to ensure the patch has adhered completely.
9. If necessary, repeat heating and rolling the patch in any areas that can be peeled back.



**CAUTION:** Do not overheat the patch or the bucket skin, as this can result in permanent damage to one or both.

## Skin Replacement

If the bucket skin gets damaged beyond repair, as defined in the above section, a replacement skin will need to be obtained from Kawak Aviation. A replacement skin will come as a lone item with the placement holes for the strap clamp fittings predrilled. The existing hardware, strap clamp fittings and plates, lift straps, and battens will need to be removed from the original skin and reused if no damage is found upon inspection. If any damage has occurred to these parts, replacements will also need to be ordered along with the replacement skin.

Tools you will need:

- Set of combination wrenches
- Deep socket set and ratchet
- Hammer and punch
- Pliers
- Blunt round rods/Phillips screwdriver
- Air compressor with hose and blow nozzle
- Alcohol
- Fish tape
- Safety wire
- Side cutters
- Clamps
- Electrical connector pliers
- Dielectric grease

**\*\*NOTE\*\*:** Utilizing an overhead hoist system to suspend the bucket makes removal and installation of the new skin much easier. If that is not an available option, the task can still be completed with additional steps and help.

### Disassembling the Skin

1. With the inlet frame expanded and locked in the open position, remove the knuckle covers and set them aside.
2. Using electrical connector pliers, disconnect the electrical harnesses from the bucket refill pump (if equipped).
3. Disconnect the zip ties and Adel clamps that secure the harnesses to the bucket skin.



4. Once free, pull the refill pump harness (if equipped) out and away from the work area to prevent damage while manipulating the bucket.  
**\*\*NOTE\*\***: If not utilizing a hoist, removing the bucket refill pump, if equipped, and setting it aside at this point will aid in maneuvering the valve base by making it lighter.
5. Remove the orange sleeve containing the actuation harness as well as the choker.
6. Coil the actuation harness around the actuator. Secure in place with cable ties as needed.
7. With the pump set aside and the actuator harness coiled on the valve base, pull the valve base onto its side.
8. Pull the inlet frame away to stretch the skin tight and gain access to the lower strap brackets that attach the lift straps to the valve base assembly.
9. Use wrenches to remove the attachment bolts and free the lift straps from the valve base assembly.
10. Use a deep socket and ratchet to loosen and remove the T-bolt clamp.
11. Pull the valve base assembly free from the bucket skin.
12. Mark the joint on the inlet frame where the rigging rope(s) with the electrical harness(es) and zip up sleeve(s) are attached to facilitate reassembly in the proper orientation.
13. With the hammer and punch, pound out the retaining pin of the sling connectors to disconnect the straps from the inlet frame.
14. Remove the frame from the damaged skin.
15. Take the skin to a flat workspace.
16. Lay it out in order to remove the lift straps and strap clamp fittings and plates.
17. Use wrenches to remove the strap attachment bolt from the clamp fitting.
18. Using compressed air, blow into the bottom of the strap pocket of the skin while simultaneously pulling the strap out of the top of the skin pocket. **\*\*NOTE\*\***: If compressed air is not available, alcohol can be used to lubricate the pocket and strap to aid in the removal.
19. Use wrenches to remove the four (4) bolts holding the clamp fittings and plates to the skin. Repeat steps 17 and 18 for all remaining straps and clamp fittings and plates. Note the location of zip tie mounts and Adel clamps during disassembly.

#### Reassembling the Skin

1. Use the four (4) bolts to attach the strap clamp fittings through the predrilled holes in the skin.
2. Torque the fasteners to 40in-lb.
3. Using compressed air or alcohol, push the end of the fish tape up through one strap pocket from the bottom of the skin.
4. Use the safety wire to create a suitable loop to attach the fish tape to the bottom loop of one lift strap.



5. Using compressed air or alcohol, pull the strap through the pocket until the bottom loop is protruding past the bottom of the skin. Ensure the loop at the top is in line with the attachment bolt at the strap clamp fitting.
6. Install the bolt and tighten until it is just snug enough not to rotate by hand.
- ⚠ **CAUTION:** Over-torquing this bolt could cause the tabs on the strap clamp fitting to break off.
7. Repeat steps 1 - 6 for all the remaining straps.
8. Bring the skin to the inlet frame.
9. Orient the skin so the strap clamp fitting with the zip tie mounts, the rigging rope with the zip up sleeve and electrical harnesses, and the joint of the inlet frame that was marked during disassembly are all lined up.
10. Using the hammer and punch, install the sling connector to the inlet frame with the lower red shackle connected to the lift strap and the upper gray shackle connected to the rigging rope.
11. Pull the rigging rope straight and follow the weave of the line from top to bottom to prevent twisting or tangling.
12. Repeat steps 10-11 for each of the rigging ropes, ensuring that none of the ropes are tangled.
13. Orient the inlet frame and attached skin such that the rigging rope with the electrical harnesses is bottommost.
14. Bring the valve base to the bottom of the skin and tip it onto its side. Clock the skin so the Adel clamps and zip tie mounts are positioned as shown. See Figure 34.

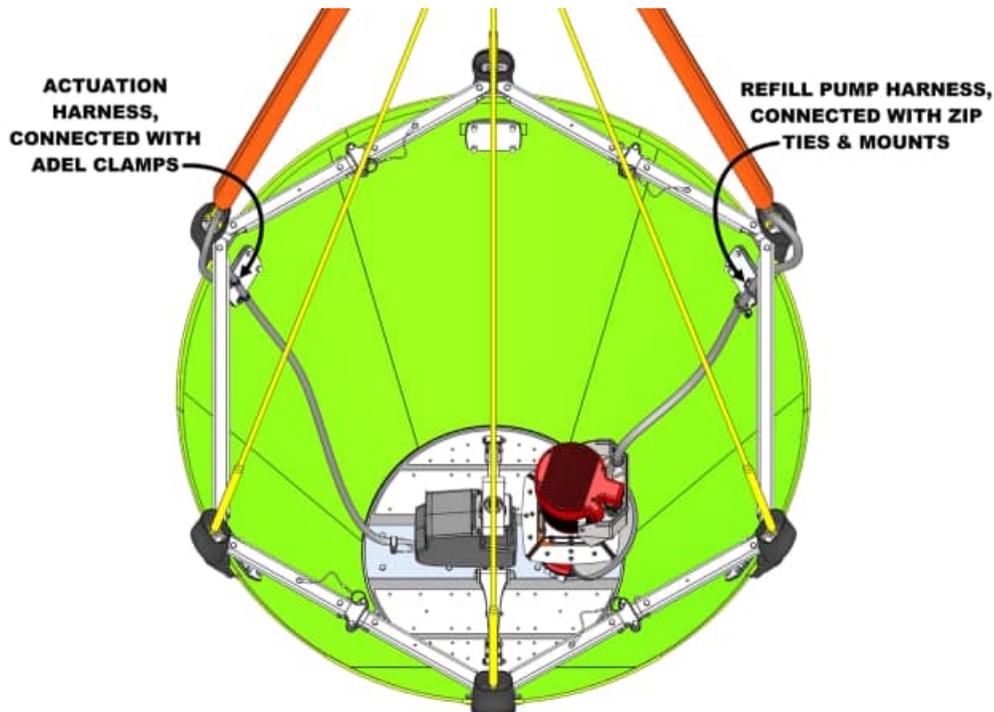


Figure 34 Skin Assembly Clocking



15. Using alcohol, round rods, clamps, and pliers, work your way around the base pulling the skin over the gasket until the bottom of the skin is flush with the bottom of the valve base. **\*\*NOTE\*\***: Make sure that the lift straps line up with the lower strap brackets on the underside of the valve base and the skin is oriented per step 14.
16. With the skin in positioned and flush with the bottom of the valve base, install the T-bolt clamp.
17. Position the clamp approximately ½" up from the bottom of the skin.
18. Wet the inside surface of the clamp's rubber cushion with alcohol and position the T-bolt between two of the lift straps.
19. Using a deep socket and ratchet, tighten the clamp to secure the skin to the base. Ensure the bolt guard is properly positioned to cover the protruding end of the T-bolt.
20. Use wrenches to reattach the lift strap & lower strap brackets on the underside of the valve base weldment.
21. Torque the fasteners.
22. Repeat steps 20-21 for all remaining straps.
23. With the straps installed, pull the valve base back to the upright position and rearrange the skin and inlet frame back around the valve base to regain the cup-like formation.
24. Reroute the electrical harnesses. Reference Figure 34 as necessary.
25. Apply dielectric grease to the face of the refill pump connector (if equipped).
26. Use electrical connector pliers to tighten the connectors securely. Apply a small amount of RTV to electrical connector threads. This acts as a non-permanent thread locking mechanism.
27. Reinstall snag shield (KCB-0000-6001-00) using the original hardware.
28. Replace the zip ties retaining the refill pump harness (if equipped) and cinch them down tight to prevent slippage. Trim off the excess from the zip ties.
29. Secure the actuation harness to the skin assembly with the existing Adel clamps. Ensure there is adequate slack in the harness, so it is not tensioned when the bucket is deployed.
30. Ensure there is adequate slack in the harnesses, so they are not tensioned when the bucket is deployed.
31. Reinstall the orange sleeve and choker on the actuation harness. Wrap the choker around only the harness; do not choker the rigging rope.
32. Ensure there is adequate slack in the harness, so it is not tensioned by the rigging rope when the bucket is deployed.
33. Replace the knuckle covers over the sling fittings at the inlet frame.
34. The bucket system is now ready to be returned to service.



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## Section 8: STOWAGE

### Pre-Stowage Maintenance

At the end of the fire season the bucket should get a thorough inspection and cleaning. Any issues found during an inspection should be resolved at this time, so that the bucket is repaired, fully functional, and ready for the next season. Once any issues are addressed, the bucket system should be washed to remove any residue accumulated during use, especially if fire retardants were used during deployment. These can be caustic and can accelerate corrosion of the materials used in the bucket system. After sufficient cleaning, the bucket must be allowed to dry completely before being folded up for storage, to prevent mold growth and corrosion.

### Stowage



**WARNING:** There are multiple pinch points throughout the next steps. Be mindful of where your hands and fingers are while manipulating the collapsible inlet frame. It is recommended to have one person in charge of this process to give directions to prevent injury.

1. Once dry, pull the quick release pins with lanyards attached to them.
2. Push the hinge blocks towards the center while pushing the solid frame members closer to each other.
3. Continue pushing the solid frame members until the frame collapses.
4. Install quick release pins if desired to secure the hinge blocks together. A tiedown can be placed around the inlet frame to keep it lightly stowed.
5. Coil rigging ropes and harnesses and place them on top of the collapsed inlet frame along with the lifting block. Alternatively, the rigging ropes, harnesses and lifting block can be stowed within the bucket to decrease overall height.
6. With the bundle secured in position or placed within the bucket, wrap one or two straps around the skin and tighten to make the bucket more compact and easier to handle and store. See Figure 25.
7. Wrap and secure the Gladiator Cargo Net around the bucket with the four (4) L-straps.
8. The bucket can now be stored as-is, or it can be put back on the shipping pallet for easy maneuvering with a forklift or pallet jack.



## Section 9: TROUBLESHOOTING

### General

This section contains information for troubleshooting the main functionality of the bucket system. The failure modes described in these sections are the most likely to be encountered during operation. Schematics of the electrical systems can be found in Section 5. If the information in this troubleshooting section does not resolve the failure mode, contact Kawak Aviation Technologies for further assistance.

### Actuation System

<b>MALFUNCTION</b>	<b>PROBABLE FAULT</b>	<b>TROUBLESHOOTING / CORRECTIVE ACTION</b>
<b>ACTUATOR INOPERABLE</b>	A. Circuit breaker tripped.	1. Check the 35A circuit breaker. If breaker trips again, clear fault & retry.
	B. Electrical power supply issue	1. Confirm the system is connected to a circuit capable of supplying >15A at 28VDC. 2. Confirm the system is configured as outlined in Section 5 and Figure 22. 3. Check all electrical connections, and confirm polarity and voltage at connector J3 are correct following the steps in the Bucket Set-Up section in Section 5. 4. Check for wire-to-wire short circuits and verify end to end continuity of the signal paths through the long line and short line using a multimeter. Repair/replace as required.



	<p>C. Faulty actuator assembly</p>	<ol style="list-style-type: none"><li>1. For reference, see figure 21 in section 5. In a quiet place, apply 28V between pin 3 (+) and pin 2 (-) on connector P3. Then apply 28V to pin 1. If listening near the actuator, an audible click should be heard once 28V is applied to pin 1 and the actuator should begin to extend and another audible click should be heard when 28V is removed from pin 1 and the actuator will retract. If these clicks are not heard and the actuator does not move, the actuator assembly will likely need to be replaced.</li><li>2. Apply 28V to pin 3 (+) and pin 2 (-) on the short line connector for the actuator (P3) and measure the current drawn. A small current (&lt;100ma) should be observed. Large current or zero current indicates a faulty actuator. Replace as required.</li><li>3. With 28V still applied across pins 3 and 2, apply 28V to pin 1 (+) to extend the actuator <u>while monitoring the current drawn</u>. Zero current or more than 5 amps while unloaded indicates reverse polarity or a faulty actuator, respectively. Removing the 28V from pin 1 should cause the actuator to retract.</li></ol>
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## 28VDC Bucket Refill Pump

MALFUNCTION	PROBABLE FAULT	TROUBLESHOOTING / CORRECTIVE ACTION
<b>BUCKET REFILL PUMP</b>		
<b>REFILL PUMP INOPERABLE</b>	A. Circuit breaker tripped	1. Check the associated circuit breaker. If breaker is tripped, reset.
	B. Electrical power supply issue	1. Confirm the system is connected to a DC circuit capable of supplying 100A (or whatever current limit the motor is set to) at 28VDC.  Confirm the system is configured as outlined in Figure 23, located in section 5.  2. Polarity Check for the 28 VDC Bucket Refill Pump in Section 5. If polarity was reversed, the pump circuitry was likely damaged and the motor will likely need to be replaced.  3. Check for short circuits and broken connections in the long line and short line using a multimeter. Repair/replace as required.
	C. Faulty motor	1. If all electrical connections are in good operating condition and the voltage, polarity and amperage requirements from the above



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		steps are met, the motor should run. If the motor still fails to run, the motor is faulty and will need to be replaced to restore pump function. Contact Kawak to obtain RMA for motor evaluation.
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## Section 10: KITS AND ACCESSORIES

Contact Kawak Customer Services for available kits and accessories.

## Section 11: THE WARRANTY

The most up-to-date version of the warranty can be accessed on the [Kawak website](#).



## Section 12: ILLUSTRATED PARTS CATALOG

### RIGGING

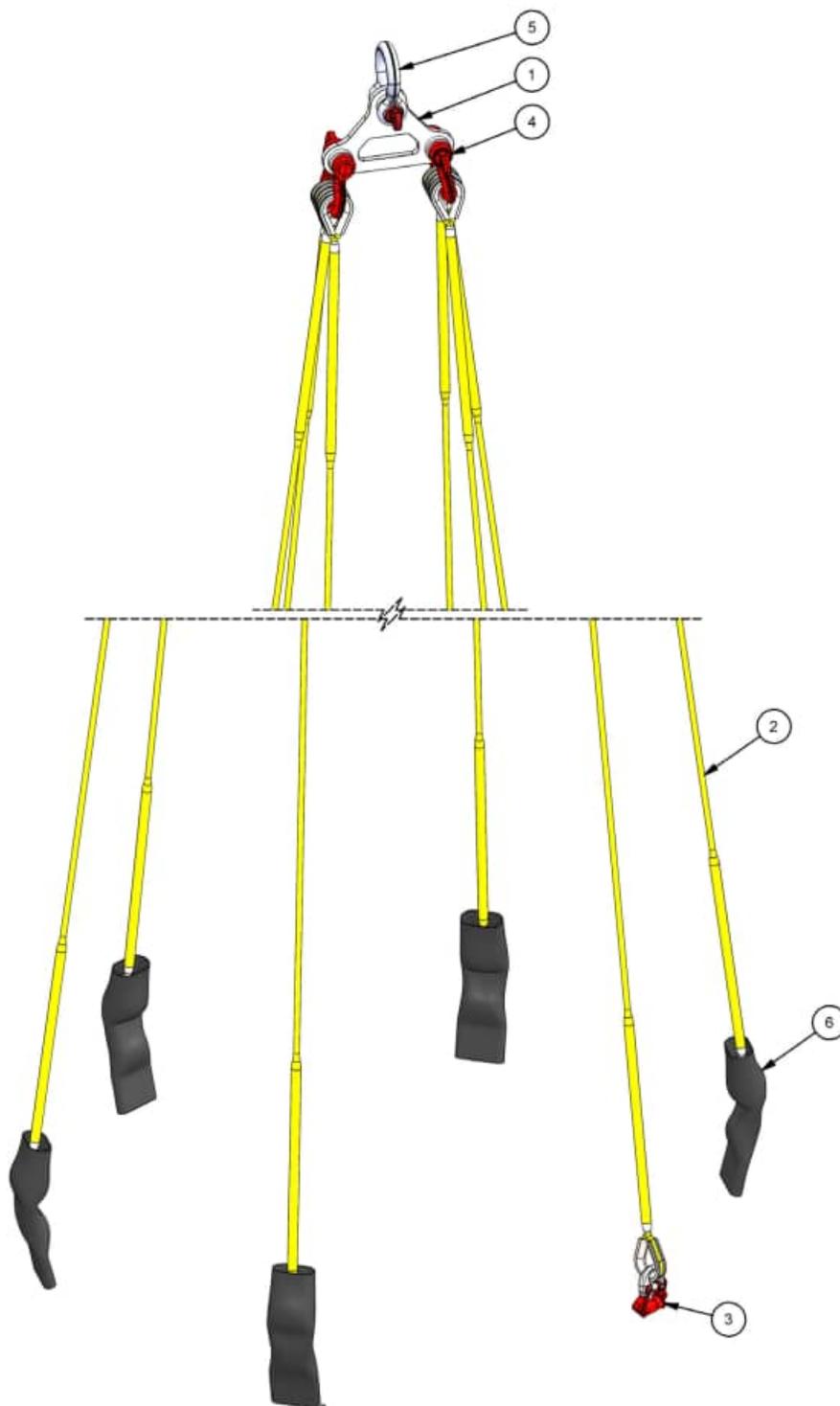




Table 8: Rigging part numbers

6	6	KCB-0000-0003-00	KNUCKLE COVER, BUCKET
1	5	1017582	SCREW PIN SHACKLE, GALVANIZED
2	4	1021075	CROSBY WEB SLING SHACKLE, SCREW PIN
6	3	1020695	SLING CONNECTOR, 2"
6	2	KCB-0000-0002-01	RIGGING ROPE ASSEMBLY, MED/LARGE BUCKET
1	1	KCB-0000-0010-01	LIFTING BLOCK WELDMENT
QTY.	ITEM NO.	PART NUMBER	DESCRIPTION



## INLET FRAME, 320 – 350 Gallon Bucket Capacity

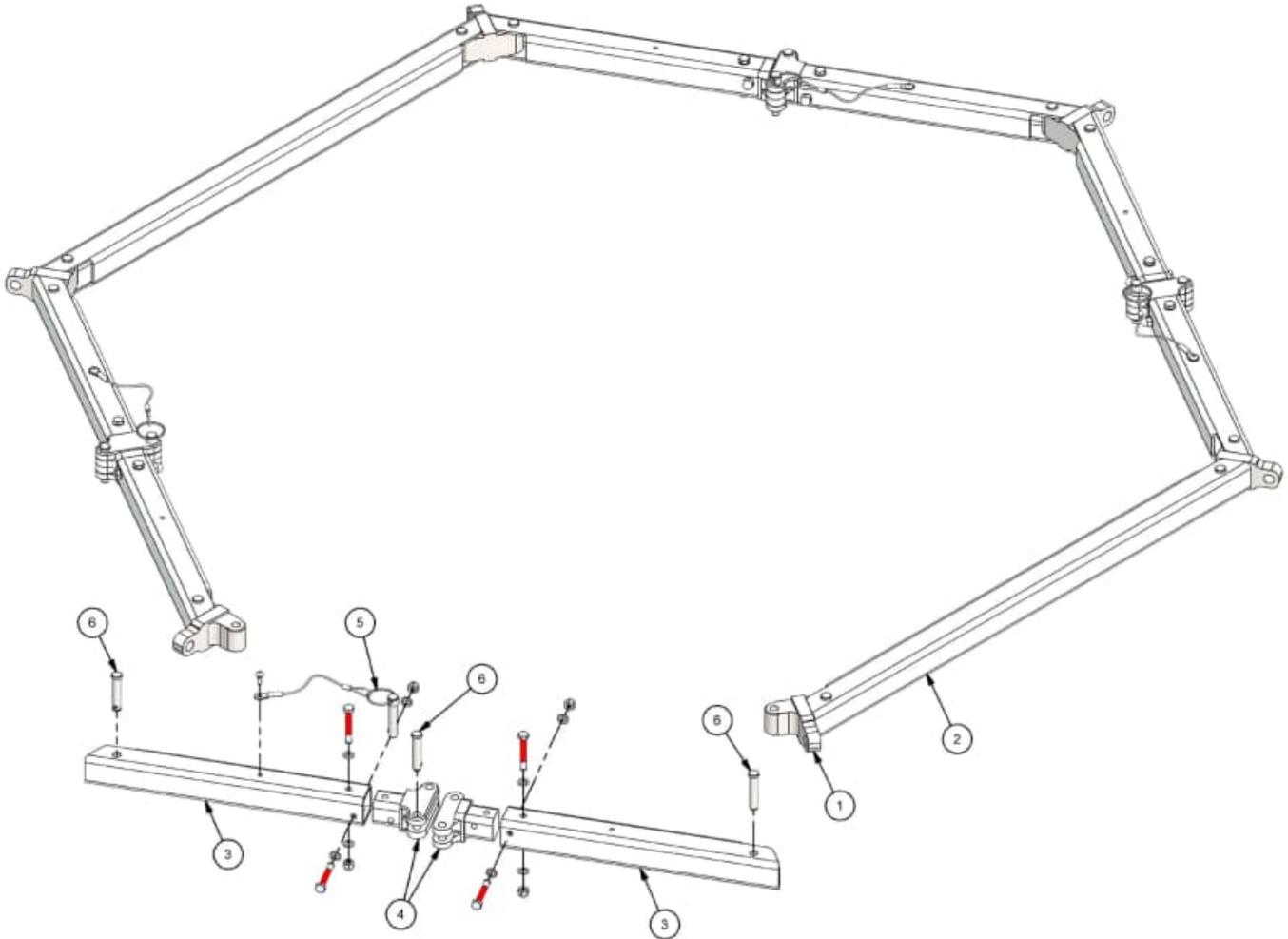


Table 9: Inlet Frame part numbers

16	6	SLP6-150S-K	PIN, SLIC, 3/8 X 1.5, SS
4	5	ASLRPS6-62N2S-K	PIN, SLIC, 3/8 X 1.5, SS, W/LANYARD
8	4	KCB-0000-4012-24	INLET FRAME HINGE BLOCK, 24" VALVE BASE
8	3	KCB-0000-4011-24	INLET FRAME TUBE, 24" VALVE BASE, BUCKET
2	2	KCB-0000-4002-24	INLET FRAME ARM, RIGID, 24" VALVE BASE, BUCKET
6	1	KCB-0000-4001-24	INLET JOINT FITTING, 24" VALVE BASE, BUCKET
QTY.	ITEM NO.	PART NUMBER	DESCRIPTION



## INLET FRAME, 260 Gallon Bucket Capacity

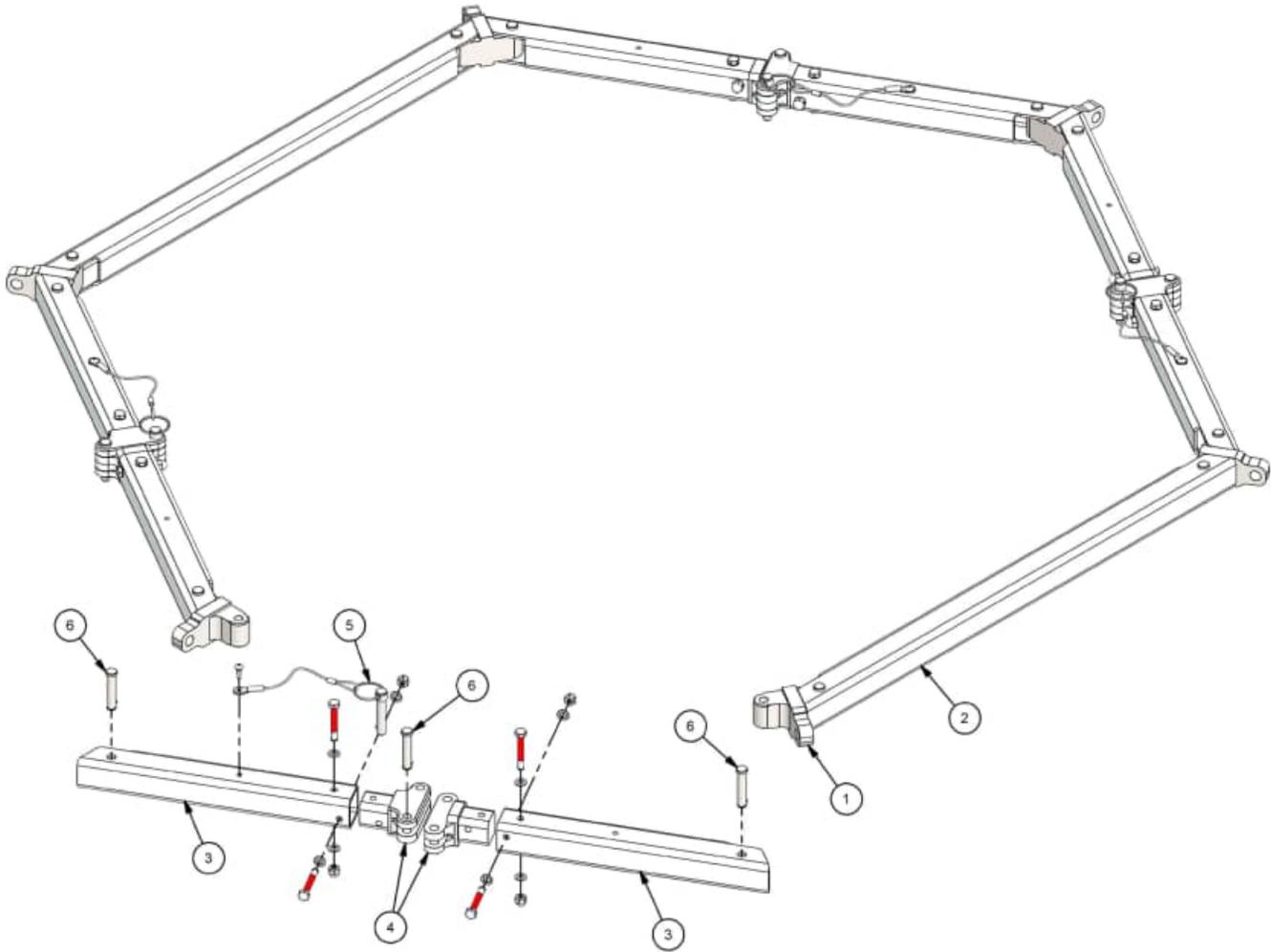


Table 10: Inlet Frame part numbers

16	6	SLP6-150S-K	PIN, SLIC, 3/8 X 1.5, SS
4	5	ASLRPS6-62N2S-K	PIN, SLIC, 3/8 X 1.5, SS, W/LANYARD
8	4	KCB-0000-4012-24	INLET FRAME HINGE BLOCK, 24" VALVE BASE
8	3	KCB-0000-4101-24	INLET FRAME TUBE, 24" VALVE BASE, BUCKET
2	2	KCB-0000-4102-24	INLET FRAME ARM, RIGID, 24" VALVE BASE, BUCKET
6	1	KCB-0000-4001-24	INLET JOINT FITTING, 24" VALVE BASE, BUCKET
QTY.	ITEM NO.	PART NUMBER	DESCRIPTION



## SKIN ASSEMBLY

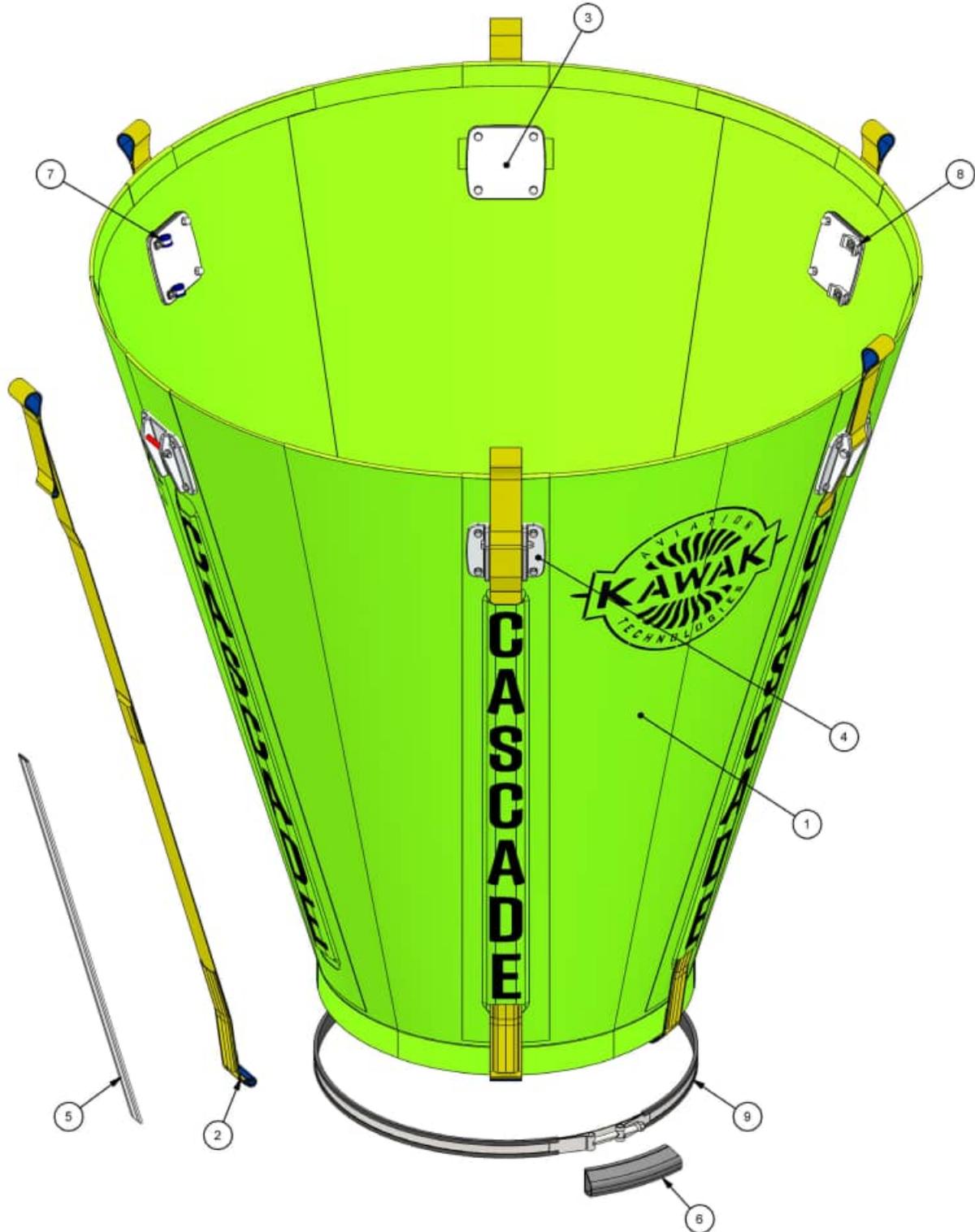




Table 11: Skin Assembly part numbers

1	1	1	9	975JR-0003	CLAMP, T-BOLT, 24" BASE, BUCKET
2	2	2	8	7582K83	MOUNT, ZIP TIE, 1/4" MOUNTING BOLT, 1/2" WIDE TIE
2	2	2	7	MS21919-WDG8	CLAMP, CUSHION, .500
1	1	1	6	KCB-0000-0005-01	CLAMP GUARD, BUCKET
6	6	6	5	KCB-0000-1003-01	SUPPORT BATTEN
6	6	6	4	KCB-0000-1005-00	STRAP CLAMP FITTING, MACHINED, BUCKET
6	6	6	3	KCB-0000-1007-00	STRAP CLAMP PLATE, BUCKET
-	-	6	2	KCB-0350-1002-24	STRAP, VERTICAL, 350 GALLON BUCKET
-	6	-	2	KCB-0320-1002-24	STRAP, VERTICAL, 320 GALLON BUCKET
6	-	-	2	KCB-0260-1002-24	STRAP, VERTICAL, 260 GALLON BUCKET
-	-	1	1	KCB-0350-1001-24	SKIN, 350 GAL, BUCKET
-	1	-	1	KCB-0320-1001-24	SKIN, 320 GAL, BUCKET
1	-	-	1	KCB-0260-1001-24	SKIN, 260 GAL, BUCKET
QTY.	QTY.	QTY.	ITEM NO.	PART NUMBER	DESCRIPTION
260	320	350			
CAPACITY (GALLON)					



## ELECTRICAL

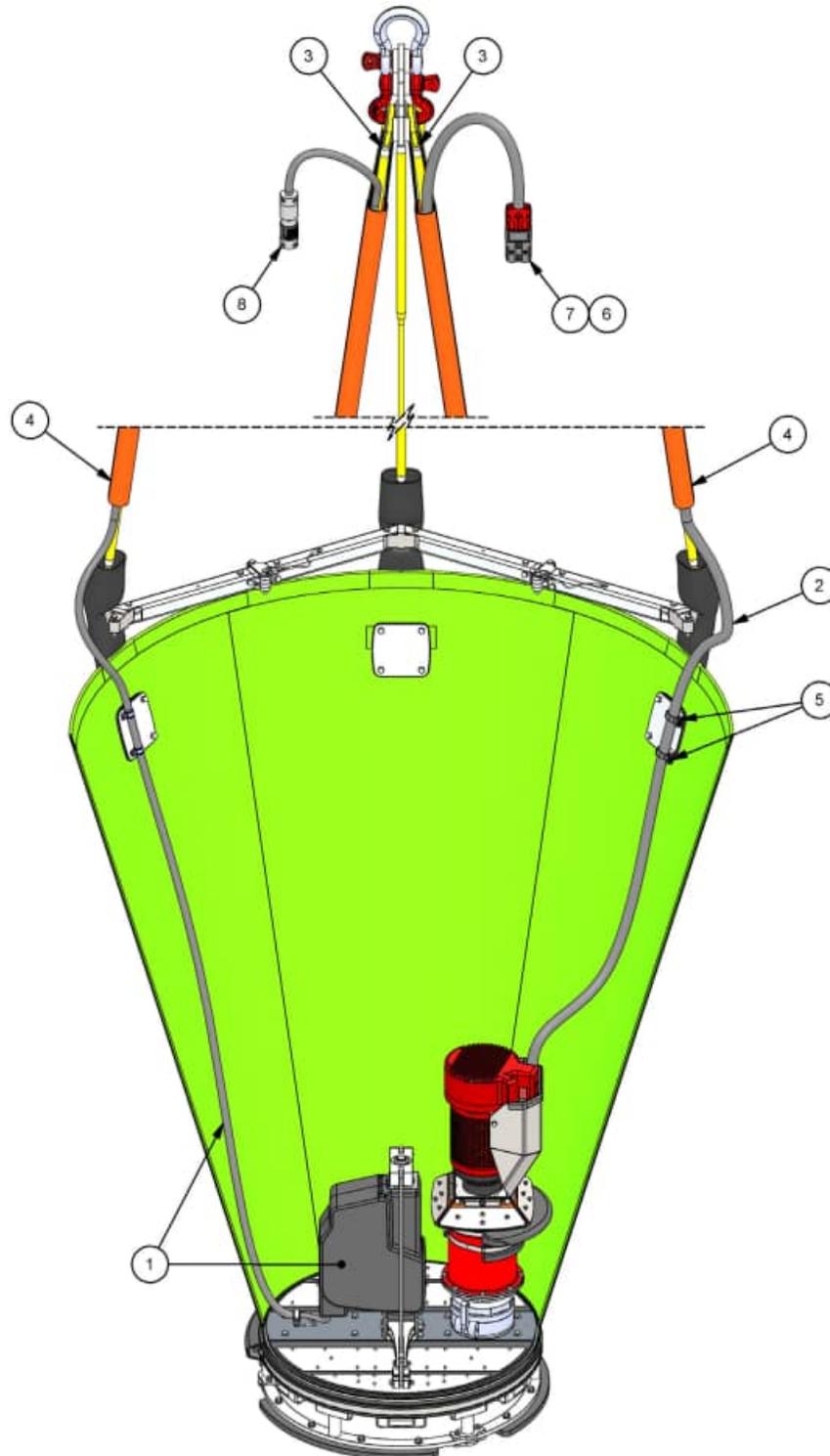




Table 12: Electrical part numbers

1	8	NEMA 5-20R	CONNECTOR, POWER RECEPTACLE 20A/125V
1	7	2-7252G11	ANDERSON CONNECTOR, SB175, BLACK
2	6	1384-BK	TERMINAL, FOR 4 AWG WIRE, ANDERSON SB175
2	5	69455K12	ZIP TIE, 1/2" WIDE, 0.09" THICK, 9" LONG
2	4	PC-CHD-.4375-PL-SOX2-180IN-ZP-O-SP	SHORT LINE SLEEVE, ZIP UP, 180" LONG
2	3	WCS-SO-1	WEB CHOKING STRAP, POWER CORDS
1	2	KCB-0000-0012-00	HARNESS, SHORT LINE, 28VDC PUMP, BUCKET
1	1	KCB-0000-2900-00	ACTUATOR ASSEMBLY, 100MM STROKE
QTY.	ITEM NO.	PART NUMBER	DESCRIPTION



## LOWER STRUCTURE

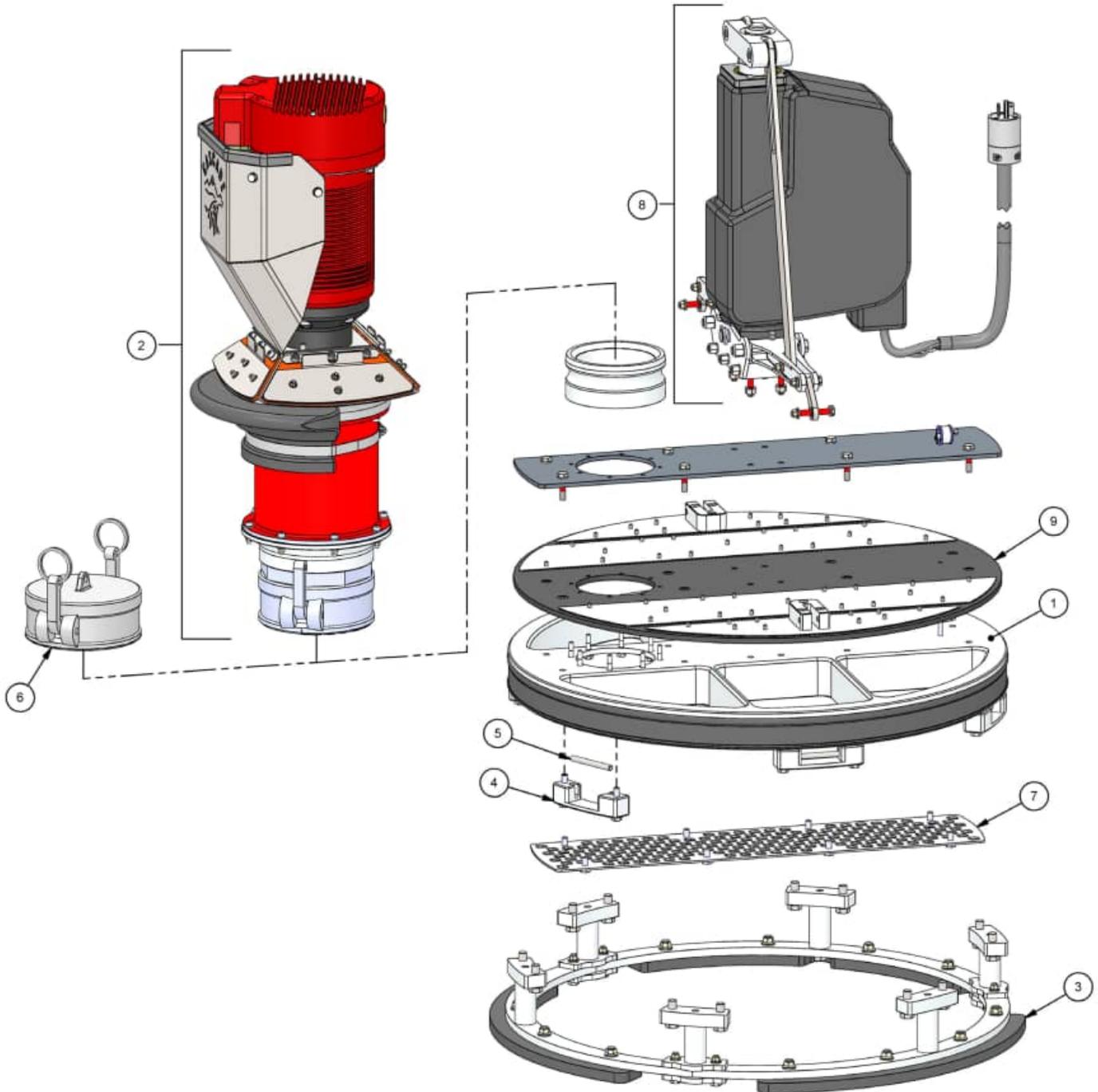




Table 13: Lower Structure part numbers

1	9	KCB-0000-2004-24	VALVE ASSEMBLY, 24", BUCKET
1	8	KCB-0000-2200-24	ACTUATION ASSEMBLY, BUCKET, 24"
1	7	KCB-0000-2009-24	INTAKE SCREEN, 24" VALVE BASE, BUCKET
1	6	51415K88	CAP, C&G, 4"
6	5	KCB-0000-2027-24	PIN, LOWER STRAP MOUNT, BUCKET
6	4	KCB-0000-2026-24	STRAP MOUNT, LOWER, BUCKET
1	3	KCB-0000-2020-24	24" VALVE BASE STANDOFF ASSEMBLY, BUCKET
1	2	KCB-0000-6000-24	PUMP ASSEMBLY, BUCKET FILL, 28VDC, 4" INTAKE
1	1	KCB-0000-2010-24	VALVE BASE ASSEMBLY, 24", BUCKET
QTY.	ITEM NO.	PART NUMBER	DESCRIPTION



## ACTUATION ASSEMBLY

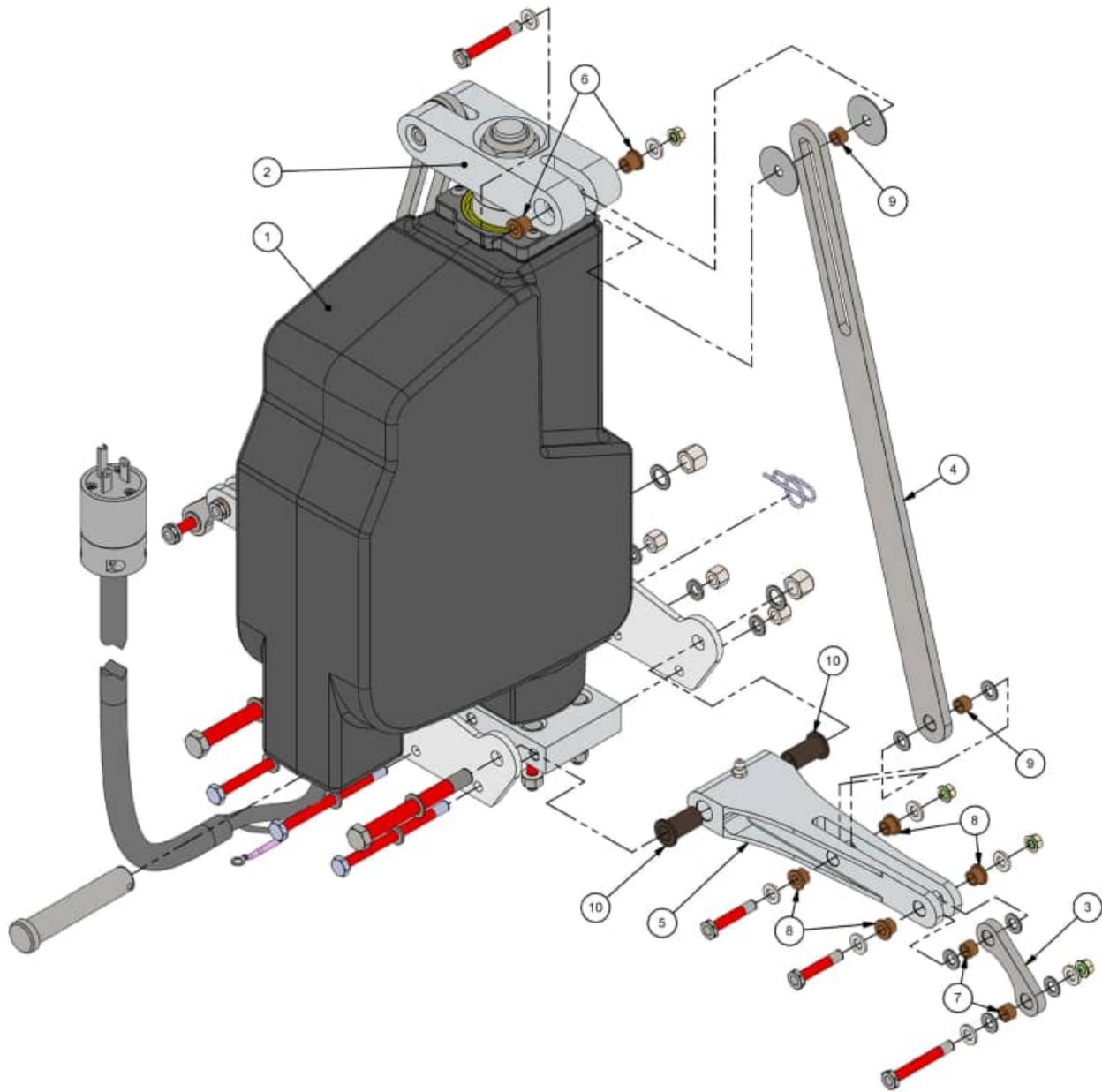




Table 14: Actuation Assembly part numbers

4	10	1677K326	FLANGED BEARING, 3/8" X 1/2" X 1", SAE 841 BRONZE
4	9	2867T43	BEARING, 3/8 OD X 1/4 ID X 1/4 LG, 954 ALUMINUM BRONZE
8	8	NAS77A4-022P	BUSHING, FLANGED, .250 X .3761 X .220
4	7	6381K412	SLEEVE BEARING, .250 X .375 X .250, SAE 660
4	6	NAS77A4-032P	BUSHING, FLANGED, .250 X .3761 X .320
2	5	KCB-0000-2401-24	ARM, VALVE BASE, ACTUATOR
2	4	KCB-0000-2601-32	LINKAGE ARM, 32" BASE
2	3	KCB-0000-2701-32	END LINK, VALVE BASE, ACTUATOR
1	2	KCB-0000-2841-32	ACTUATOR LINKAGE FITTING
1	1	KCB-0000-2900-00	ACTUATOR ASSEMBLY, 100mm STROKE
QTY.	ITEM NO.	PART NUMBER	DESCRIPTION



## BUCKET REFILL PUMP

Motor Guard, 28 VDC Motor

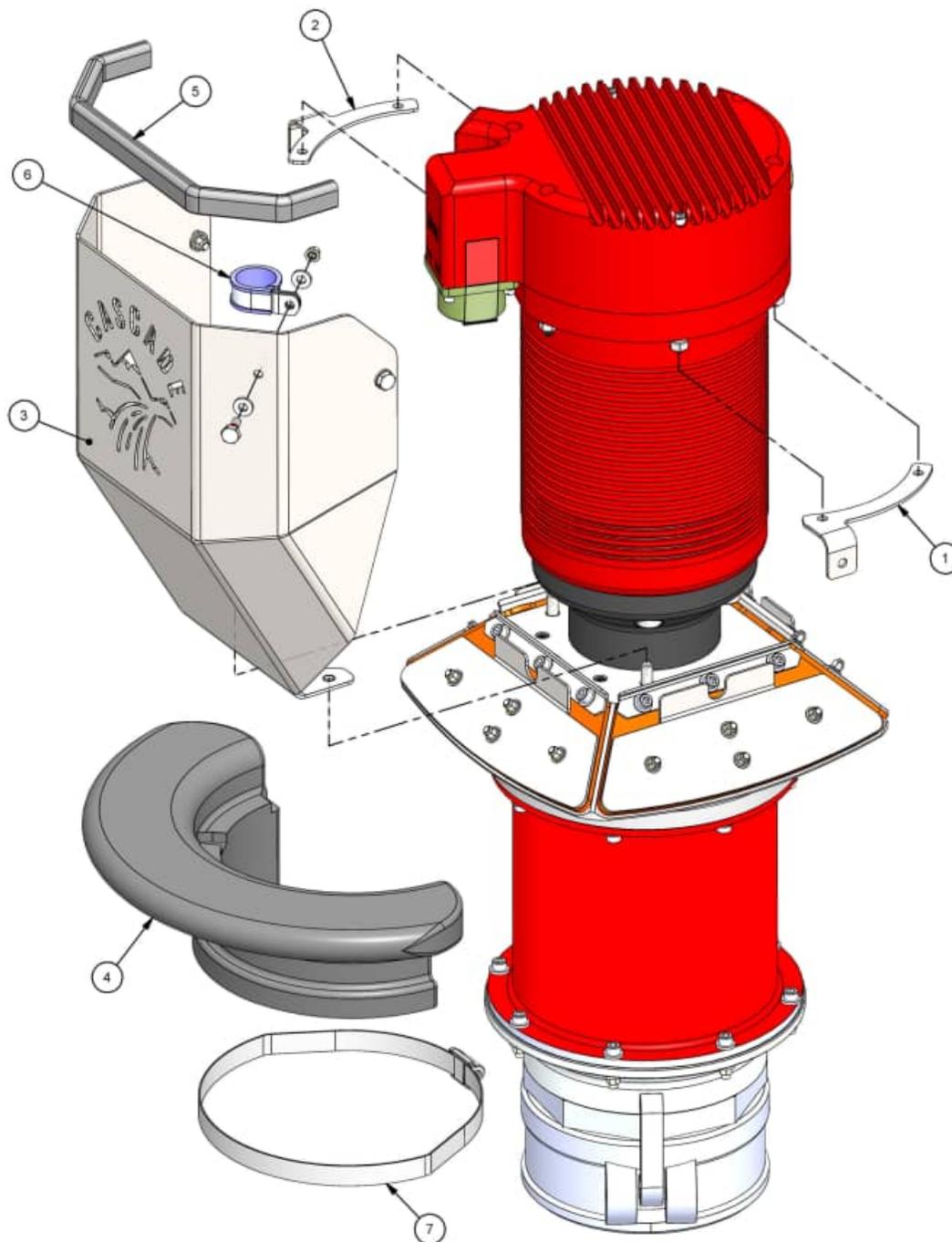




Table 15: Bucket Refill Pump Motor Guard, 28 VDC part numbers

1	7	5415K38	HOSE CLAMP, SS, 0.5" WIDE, 4.13" TO 7.00" DIA.
1	6	MS21919WDG-14	CLAMP, CUSH., .875
1	5	KCB-0000-6008-24	SNAG SHIELD EDGE TRIM, BUCKET
1	4	KCB-0000-6007-24	BUMPER, BUCKET REFILL PUMP
1	3	KCB-0000-6001-00	SNAG SHIELD, 28VDC MOTOR, BUCKET
1	2	KCB-0000-6002-00	UPPER SNAG SHIELD MOUNT, PLUG SIDE
1	1	KCB-0000-6003-00	UPPER SNAG SHIELD MOUNT
QTY.	ITEM NO.	PART NUMBER	DESCRIPTION



Pump Assembly

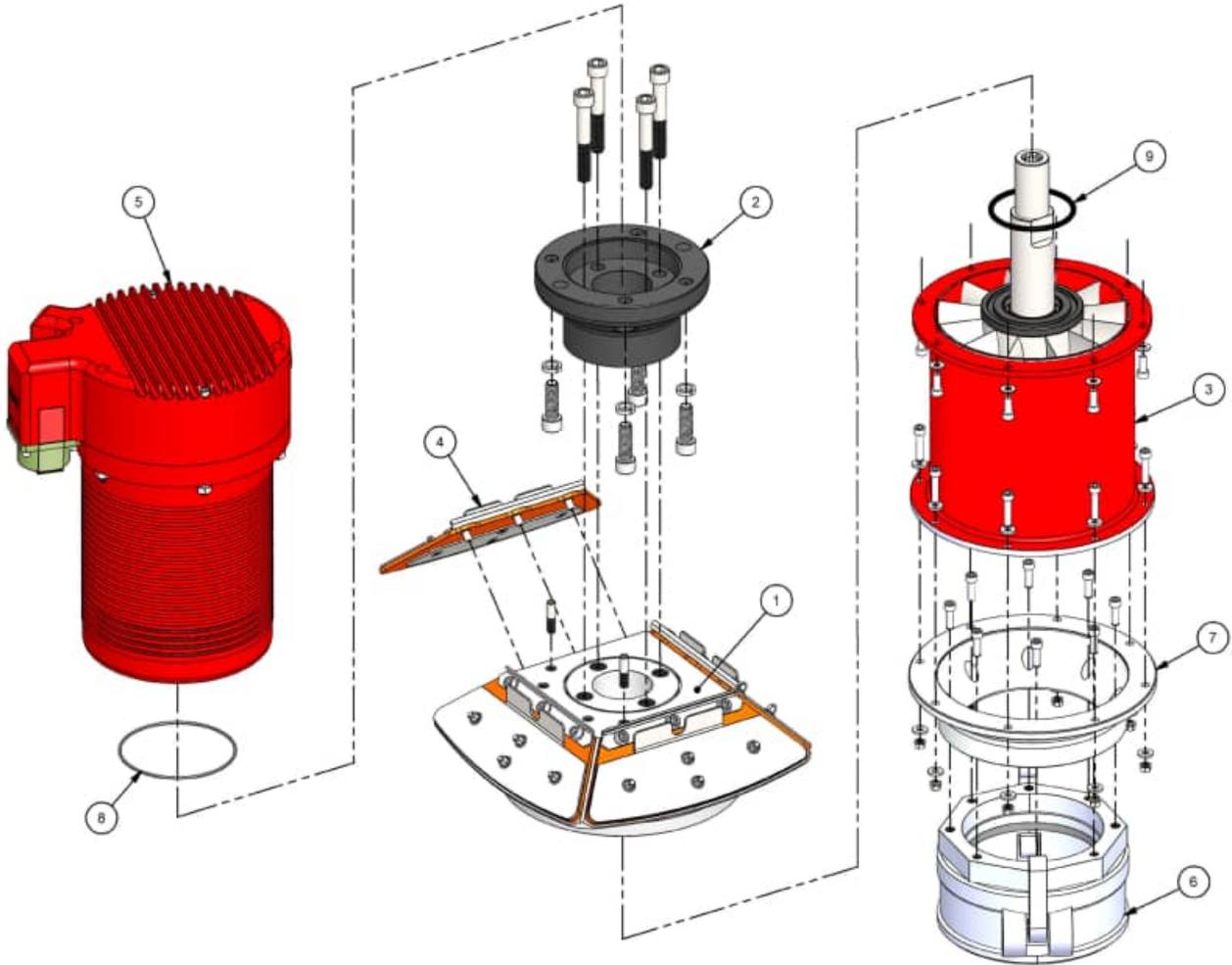


Table 16: Pump Assembly part numbers

1	9	2-228V75BR	O-RING, 2-1/4 X 2-1/2, VITON
1	8	2-042V75BR	O-RING, 3-1/4 X 3-3/8, VITON
1	7	KCB-0000-6006-24	CONVERTER, 6" TO 4", BUCKET REFILL PUMP
1	6	KCB-0000-6004-24	C&G FITTING, MACHINED, BUCKET REFILL PUMP
1	5	42394-0000	MOTOR ASSY, VARIABLE SPEED, 28V BLDC
4	4	42302-2300	CHECK VALVE, COAXIAL DISCHARGE, BUCKET
1	3	42302-0800	PUMP, IMPELLER & STATOR, ASSEMBLY
1	2	42302-0705	MOTOR MOUNT, BFP, BUCKET
1	1	42302-0704	BELL HOUSING, BFP, BUCKET
QTY.	ITEM NO.	PART NUMBER	DESCRIPTION



Impeller and Stator Assembly

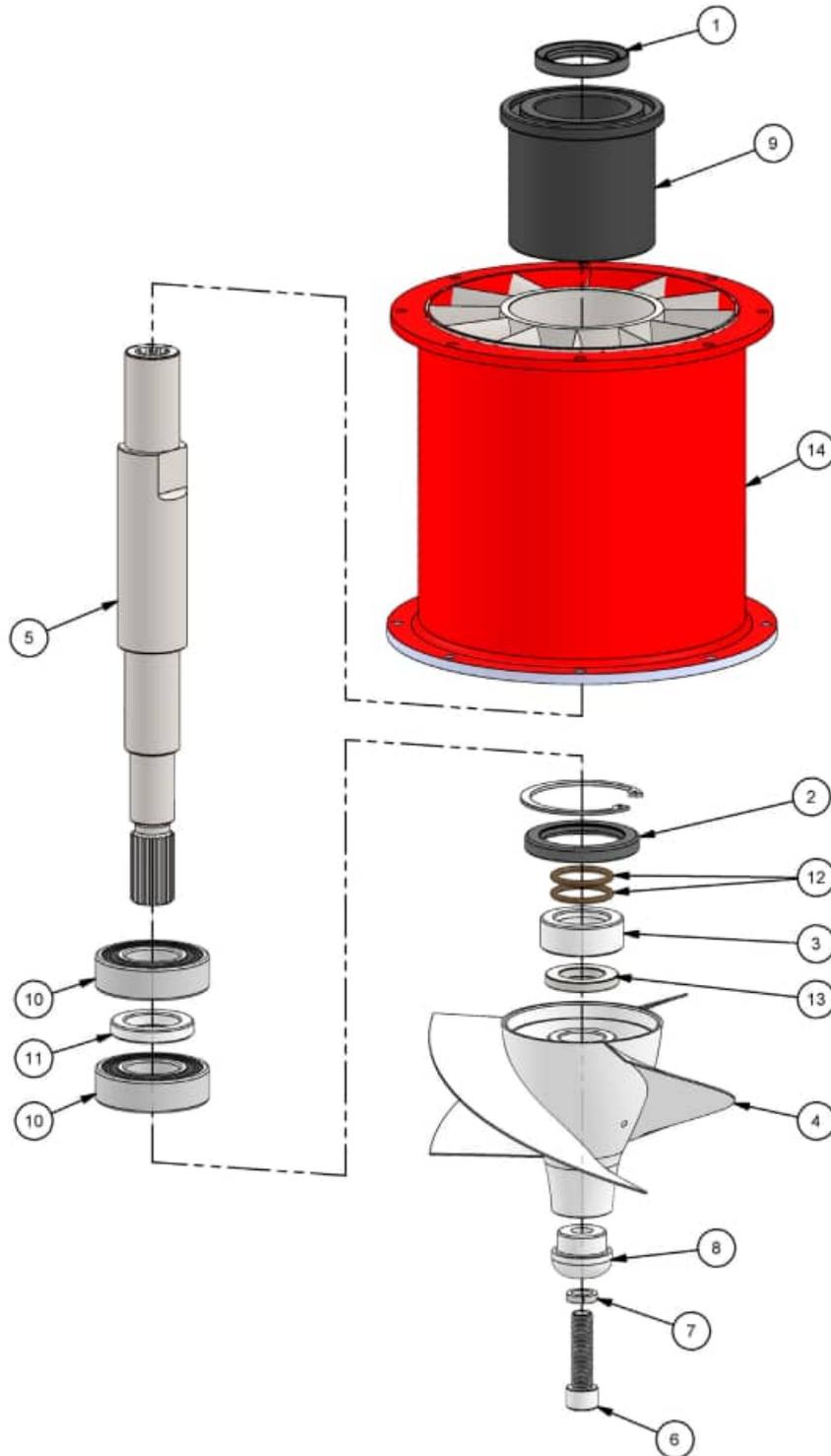




Table 17: Impeller and Stator Assembly part numbers

1	14	42302-0901	STATOR, MACHINED HOUSING, BUCKET
1	13	42302-0803	SPACER, IMPELLER, BUCKET V1
2	12	2-119V75BR	O-RING, 1 X 1.1875, VITON
1	11	38416-1	SPACER, STATOR BEARINGS INNER RACE
2	10	SS6205-2RSH	BEARING, SS, .984x2.047x.591
1	9	42302-0902	SLEEVE, STATOR, BUCKET
1	8	38420-1	RETAINING PLUG, IMPELLER
1	7	98437A115	LOCKWASHER, HC, 3/8, SS
1	6	92196A684	SHCS, 3/8-24 UNF X 1.375, SS
1	5	42302-0802	SHAFT, IMPELLER, BUCKET
1	4	38418-1	IMPELLER, ELECTRIC HOVER PUMP
1	3	38415-1	SLEEVE, SHAFT SEAL, BFP
1	2	152062TSS	SEAL, 1.500x2.062x.250 BUNA
1	1	12162TSS	SEAL, 1.250x1.687x.250, BUNA
QTY.	ITEM NO.	PART NUMBER	DESCRIPTION



Check Valve Assembly

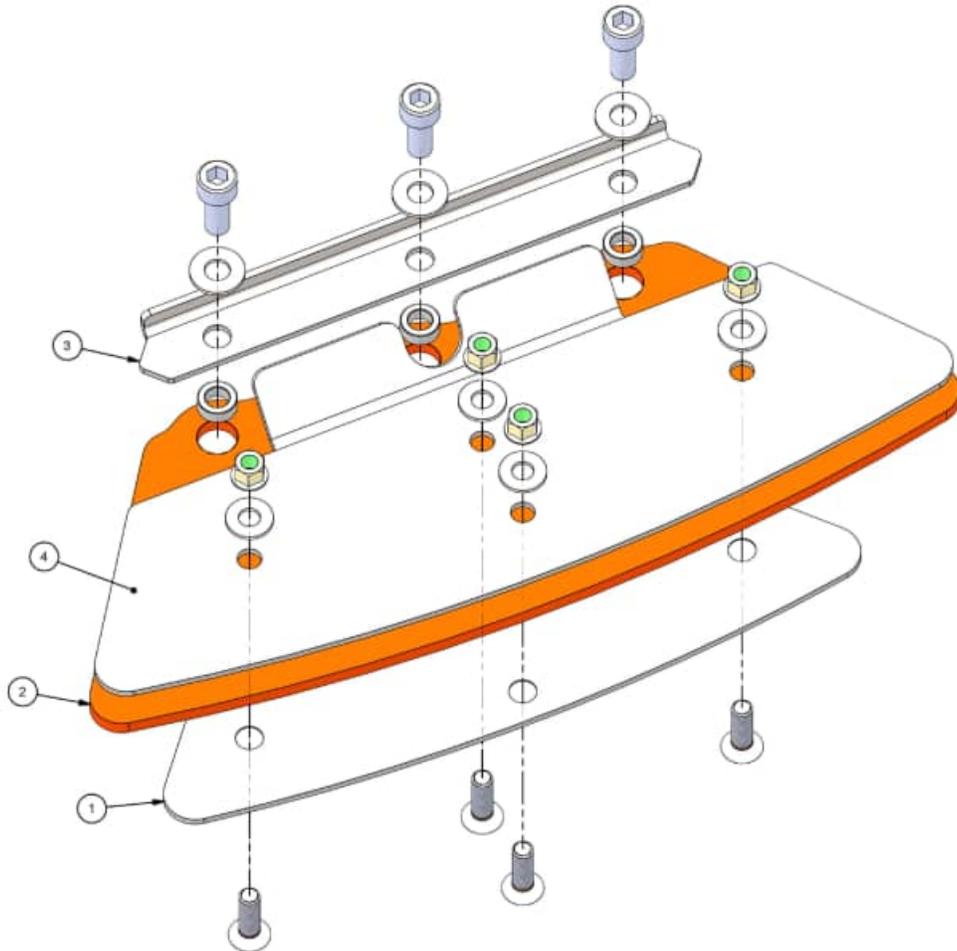


Table 18: Check Valve Assembly part numbers

1	4	42302-2304	PLATE, CHECK VALVE, BUCKET
1	3	42302-2303	CLAMP PLATE, CHECK VALVE, BUCKET
1	2	42302-2302	SEAL, CHECK VALVE, BUCKET
1	1	42302-2301	BACKING PLATE, CHECK VALVE, BUCKET
QTY.	ITEM NO.	PART NUMBER	DESCRIPTION

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