

# OPERATION & MAINTENANCE MANUAL



## Spartan ERV 100' Tractor Drawn Aerial Ladder

Model TL100-4-500

2013 Spartan ERV

Part No.

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#### **INTRODUCTION**

#### HANDBOOK SECTIONS

The following is an overview of the individual sections contained in this handbook. Together, these sections provide trained and qualified personnel with information essential to operate a Crimson Aerial Ladder Apparatus for its intended use.

**DANGER/WARNING PAGE** contains DANGER and WARNING notices which have a "blanket application" for most or all sections/procedures in this handbook.

**GENERAL INFORMATION** contains illustrated, descriptive presentations of apparatus configurations, specifications, major components, and basic operating systems.

**SAFETY PRECAUTIONS** lists mandatory and precautionary items which must be strictly followed in order to promote safety in application, operation and basic servicing.

**CAPACITIES AND LIMITATIONS** explains the proper use of the aerial load chart in determining permissible operating limits and load capacities.

**CONTROLS AND INDICATORS** describes the location and function of all aerial, outriggers, and miscellaneous controls and indicators required for aerial operation including overrides and emergency controls.

**APPARATUS READINESS CHECKS** provides a "Daily Checklist" of items which must be confirmed serviceable, prior to declaring the apparatus in a "state of readiness." The checklist is supplemented with a "Walk-A-Round Inspection Diagram."

**SET-UP PROCEDURES** contains priority considerations for apparatus set-up, as well as pre-op requirements for operating the aerial.

**OUTRIGGER OPERATION** includes procedures for operating the outriggers (deploying and stowing) under normal and override/emergency conditions. Also includes apparatus leveling procedures.

**AERIAL OPERATION** provides detailed instructions for operating the aerial and performing all ladder functions under normal and override/emergency conditions.

**EMERGENCY POWER UNIT (EPU) OPERATION** includes emergency hydraulic pump operating procedures for both the outrigger and aerial systems.

**LUBRICATION** describes recommended lubricants, hydraulic oils, types of lubrication points, application methods and intervals. An illustrated lubrication chart is also included.

**SERVICE AND MAINTENANCE** provides basic and detailed instruction on corrective action for a variety of systems and conditions which may occur over the life of the apparatus.

Preventative measures are also identified which will prolong the life of the unit. The troubleshooting section follows a Trouble-Cause-Remedy method of unit servicing.

**GLOSSARY** defines technical terms, describes fire apparatus terminology, explains basic component functions, and lists abbreviations used in this handbook.

#### **OPERATOR'S MESSAGE**

The purpose of this manual is to provide you, the operator, with essential information regarding aerial familiarization, operation, apparatus limitations and capacities, emergency procedures, daily servicing requirements, and additional data needed to maintain a serviceable unit in a "state of readiness" condition. The descriptive information and procedures herein enable qualified personnel to operate all systems effectively with optimum results.

This Operator's Manual must be read and understood prior to operating your **Crimson Fire** Aerial.

Operators must be aware of and comply with all manufacturers' instructions.

Failure to comply with manufacturer's instructions and safety guidelines will result in serious injury or death.

**Crimson Fire** reserves the right to change, improve modify or expand features of its equipment at any time. Specifications, models, or equipment are subject to change without notice, and without incurring any obligations to change, improve, modify or expand features of previously delivered equipment. Modifications of this machine from original design and specifications without written permission from **Crimson Fire** are strictly forbidden. A modification may compromise the safety of the machine, subjecting users to serious injury or death. Any such modification will void any remaining warranty.

This manual does not replace, nor does its use absolve the owner from complying with any and all applicable government, state/province regulations, safety codes, operating limitations, fire company procedures, and insurance requirements.

Pay special attention to the Safety Precautions Section and, most particularly, all DANGER, WARNING, and CAUTION notices strategically placed throughout this manual. These items, combined, form the guidelines for promoting a safe and efficient operating environment with continuous, reliable service and minimum apparatus downtime.

### YOU are the KEY to the QUALITY and EFFECTIVENESS of AERIAL PERFORMANCE.

Your Crimson Fire Aerial has been designed, manufactured and tested to provide many years of dependable service. To obtain the full benefit of your Aerial, always follow the proper operating

and maintenance procedures as outlined in this manual. Only trained, authorized personnel should be allowed to operate or service this machine. Service personnel should read and study this manual in order to gain a thorough understanding of the functions of the unit prior to making any repairs.

#### **PRECAUTION DEFINITIONS**

**DANGERS, WARNINGS, CAUTIONS,** and **NOTES** are strategically placed throughout this manual to further emphasize the importance of personal safety, qualified operating personnel, and proper use of the apparatus in its intended application. These text items supplement and/or complement the safety decals affixed to the apparatus and are defined as follows:



Indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.



Indicates a potentially hazardous situation or practice which, if not avoided, could result in death or serious injury.

\* (Orange)



Indicates a potentially hazardous situation or practice which, if not avoided, will result in damage to equipment and/or minor injury.

- NOTE: Indicates an operating procedure, practice, etc., or portion thereof which is essential to highlight.
  - \* Indicates the color of the sign panel on apparatus decal.

#### GENERAL DANGERS AND WARNINGS.

The following **DANGER** and **WARNING** precautions are those in a category applicable anytime the apparatus is in operation. **DANGER** and **WARNING** precautions appearing within the individual sections of this handbook are, for the most part, specific to the task or operation being defined.

#### **OPERATION**

- AN UNTRAINED OPERATOR SUBJECTS HIMSELF AND OTHERS TO SERIOUS INJURY OR DEATH
- YOU MUST NOT OPERATE THIS APPARATUS UNTIL YOU HAVE BEEN PROPERLY TRAINED.
- YOU MUST NOT OPERATE THIS APPARATUS UNTIL YOU HAVE READ AND THOROUGHLY UNDERSTAND ALL SECTIONS OF THIS MANUAL.
- WHEN OPERATING THIS APPARATUS, YOU MUST STRICTLY ADHERE TO ALL SAFETY PRECAUTIONS AS WELL AS YOUR EMPLOYER'S WORK RULES, AND ALL APPLICABLE LOCAL, STATE/PROVINCE AND GOVERNMENT REGULATIONS.

#### ELECTROCUTION HAZARD

THIS APPARATUS IS NOT INSULATED. SERIOUS INJURY OR DEATH WILL RESULT FROM CONTACT WITH, OR INADEQUATE CLEARANCE FROM, ENERGIZED CONDUCTORS.

ASSUME THAT ALL ELECTRICAL CONDUCTORS ARE "LIVE."

- KEEP SAFE DISTANCES FROM ELECTRICAL POWER LINES AND A "CHARGED" APPARATUS.
- WHEN OPERATING IN CLOSE PROXIMITY TO POWER LINES, BE SURE TO ALLOW FOR LADDER SWAY, BOUNCE, AND DEFLECTION. ALSO, BE PREPARED FOR EFFECTS OF WIND, SNOW, ICE, ETC. ON POWER LINES.

#### SEATS AND OCCUPANTS

ALL OCCUPANTS MUST BE SEATED AND SEAT BELTS SHOULD BE SECURED WHEN THE APPARATUS IS TRAVELING.

#### **OPERATION**

- INSPECT CHASSIS AND AERIAL DAILY, PRIOR TO USE. REPORT ANY DEFICIENCIES TO THE GOVERNING AUTHORITY.
- OUTRIGGERS MUST ALWAYS BE SET ON SOLID FOOTING TO PREVENT TIPPING.
- OPERATORS MUST WEAR A BODY BELT WITH LANYARD, AND ATTACH TO LADDER.
- OPERATORS SHOULD WEAR APPROVED, PROTECTIVE TURNOUT GEAR.
- ALWAYS REFER TO AERIAL LOAD CHART WHEN OPERATING; NEVER RELY ON MEMORY. NEVER LOAD AERIAL BEYOND THE RATED CAPACITIES.

#### SECTION 1 GENERAL INFORMATION

#### **CRIMSON AERIAL SPECIFICATIONS – TYPICAL (See** Figure 1)

The specifications given are typical for Crimson aerial ladder configurations. Where components and/or systems are peculiar to specific models, these items are noted to that affect.

#### **Telescopic Ladder**

Steel, welded construction with multiple telescopic sections driven by hydraulic cylinders and cables with high handrails and K-braced rungs.

MODEL	RETRACTED LENGTH	RATED REACH**	RATED HEIGHT*
RL-103	33.9' (10.3m)	<u>96' (29.3m</u> )	<u>103' (31.4m)</u>
ML-103	33.9' (10.3m)	96' (29.3m)	103' (31.4m)
TL-103	33.9' (10.3m)	96' (29.3m)	103' (31.4m)

\*Per NFPA 1901 standard, this dimension is measured at full elevation (75deg) and full extension, from the top ladder rung perpendicular to ground.

\*\*Per NFPA 1901 standard, this dimension is measured at zero degree elevation and full extension from the rotation centerline to the last rung of the ladder

For this table, the minimum heel pin height is assumed at 8'-0". This dimension will vary slightly relative to customer overall travel height specifications and chassis types.

#### **Power Take-Off**

Direct drive off of chassis transmission used to power aerial hydraulic pump.

#### Hydraulic Oil Reservoir.

All steel, welded construction with removable clean-out access; integral baffles, filter, and strainer; gated suction, drain valves and magnetic drain plugs. Capacity: 40 Gals. (151 liters).

#### Hydraulic System Filters

Pressure type with bypass in supply line; bypass-type in return line (inside reservoir); both utilize elements with a ten micron (nominal) rating.

#### Main Hydraulic Pump

Unit is equipped with an axial piston, variable-displacement type pump with a capacity of approximately 25 gpm (75.7 l/m).

#### **Emergency Power Unit (EPU)**

12 volt dc; 1.5 gpm @ 2000 psi (5.7 1/m. @ 138 bar).

#### X-Style Outrigger System

Under slung outriggers provide for lowering of the outrigger beam housing and extension of the outrigger beams and jacks. Actuator movements are provided by double-acting hydraulic cylinders with integral holding valves and large range of leveling capability.

#### Load Chart

Mounted at each aerial control station, the Load Chart identifies aerial and platform capabilities for reach, height and capacity to permit safe and efficient use of the unit. Instructions relating to proper aerial use and special situations are also included on the chart.

#### Ladder Elevation System

Dual, double-acting hydraulic cylinders with integral holding valves with an operating range from -10 to +75 degrees of elevation.

#### **Elevation Angle Indicator**

A liquid filled indicator mounted in view of the aerial control station that shows angle of elevation as ladder is raised. Angle values are used to determine proper loading as identified by Aerial Load Chart



Figure 1 General Arrangement, Rear Mount - Typical.



Figure 2 General Arrangement, Tractor Drawn - Typical.

Figure 3 General Arrangement, Mid Mount - Typical.

#### Aerial Rotation System

Antifriction ball bearing and ring gear attach aerial to chassis, providing 360 degree continuous rotation. The rotation is powered by dual planetary gear reduction drives. Drives are powered by hydraulic motors with automatic, disc-type brake.

#### Ladder Telescopic System

Dual, extension/retraction cylinders and cable drives combined with pulleys.

#### Extension Taping

Reflective tape on ladder sections permits identifying of ladder extension values for use with Aerial Load Chart.

#### **Remote-Controlled Monitor**

Electrically powered master stream device with adjustable nozzle assembly; electrically-powered monitors with retractable mount permits pinning monitor and nozzle assembly to ladder fly section, or to outer-mid section, allowing fly section operation with "clean" profile; controls provided at both aerial tip and at aerial control console. Monitor rotates 135 degrees, from below horizontal to parallel with ladder; nozzle stream pattern from straight to fog. On all models, the monitor can be rotated 90 degrees left and right of ladder centerline. An optional "butterfly" valve mounted below the monitor is used to restrict or stop water flow. Optional tip pre-connects are offered which require that a butterfly valve be installed to at the base of the monitor to block flow to the monitor and divert water to pre-connects.

NOTE: Restrictions to water flow should not be attempted without prior communication of intentions with the pump operator.

Easily reached electrical control switches or manual turning wheel controls allow positioning of monitor in degrees vertically and degrees horizontally. Monitors can be equipped with remote or manually controlled nozzles to allow control of water flow shape. Remote controls for monitor and nozzle, when applicable, are located at ladder tip and turntable areas.

#### **Monitor Auxiliary Battery**

A 12 volt dc, auxiliary battery is installed in a watertight enclosure which is mounted to the outside on the retractable monitor carriage. The battery provides limited power for monitor operation in the event of a power failure and supplies additional current to the control motors when they are operated against their stops. Design of the electrical circuit affords "trickle" charging of the battery, even when the aerial is not in use.

#### AERIAL LOAD SENSING HYDRAULIC SYSTEM

#### **Basics of Operation**

Primary power is supplied by the chassis engine to the truck's transmission which drives a mechanically-coupled power take-off (PTO). The PTO transmits the mechanical force developed by the engine to drive the main hydraulic pump. With the pump operating, oil flows from the reservoir to the inlet port of the pump.

In order for work to be performed in a hydraulic circuit, two elements must be present namely VOLUME and PRESSURE. Although these items are interrelated, each has its own particular job to do. VOLUME is the amount of oil that the pump will flow through the system in a given period of time at a designated pump speed. This flow is expressed in gallons per minute (gpm) or litres per minute (lpm).

PRESSURE, expressed in pounds per sq. in. (psi) or bar, is the amount of force (work capability) exerted by the hydraulic oil on all parts of a functioning circuit connected to the pump outlet. The amount of pressure developed in a circuit has no relationship to the speed (rpm) at which the pump is running. With the pump operating and all function controls in neutral (centered position); the oil merely circulates within the pump cavity under negligible pressure. When a load or restriction is introduced into the system - moving a function control out of neutral (center) position - pressure develops immediately in the selected circuit. Pressure will continue to increase until the pressure required by the actuator is met, or control is returned to, or reversed toward neutral, or until pressure reaches the limit of the circuit's pressure control valve(s). The pressure control valve(s), with either fixed or adjustable settings, limit(s) the maximum operating pressures to the levels for operation of the circuit's activator(s), e.g., cylinder, motor, etc. performing the work. Relief valves also protect components from damage due to excessive pressure build-up.

This hydraulic system is equipped with a load sensing variable displacement pump. A variable displacement pump operates on what could be defined as a supply and demand principle. Pressure will increase in the circuit to the levels required for moving the actuator(s) and the regulating elements, integral of the pump, and will not allow pressure to build up beyond the circuit's operating requirement. As the control is returned to neutral (centered), pressure decreases.

#### AERIAL ELECTRICAL SYSTEM

#### **Basics of Operation**

Primary aerial systems and accessories requiring electrical power are supplied by the chassis' electrical system. The aerial system consists of hardwired and multi-plexed circuits and utilizes the chassis as a negative ground. Power from the chassis' system is transferred to the aerial through a combination fully enclosed swivel which accommodates a center waterway, hydraulic ports and the electrical swivel connection. This connection consists of numerous sets of brushes and brush holder assemblies, collector rings, and connectors, which permit uninterrupted current flow to the aerial circuits through 360 degrees of aerial rotation.

Various wiring harnesses and multi-plex cables provide both point-to-point connections and multi-plex functionality, with junction boxes and nodes providing aerial and accessory circuits. All circuits are "fused" (overload protected) and identified by number.

#### AERIAL WATER SYSTEM

#### **Description**

Aerial units equipped with an aerial waterway employ a system consisting of the following major assemblies: water supply (on-off) valve, drain/dump valve, swivel assemblies for aerial rotation, ladder pivot, aluminum telescopic waterway, monitor and nozzle assembly, and associated controls, indicators, and hardware.

NOTE: Water system configurations vary, dependent upon customer specifications.

The waterway is mounted to the underside of the ladder sections and fed from beneath the turntable, through the water section of the swivel coupling. The electro-hydraulic-hydro swivel coupling permits water flow through full 360 degree, continuous turntable rotation. An aluminum offset elbow at the ladder heel pin provides unimpeded water flow up the aerial waterway, regardless of the elevation angle.

A base section and telescoping sections make up the aerial portion of the water supply piping. The sections are graduated in one-half inch increments, four section aerial ladders begin with a 5-inch (12.7cm) O.D. base pipe and end with a 3-1/2 inch fly pipe. Three section aerial ladders begin with a 4-1/2 inch O.D. base pipe and end with a 3-1/2 inch fly pipe.

A 2-1/2 inch relief valve is mounted below the turntable in the lower waterway and protects the waterway from high pressures resulting from excessive supply water coming into the system or a closed butterfly valve at the monitor (preconnects closed). Preconnects can also be supplied with swivels and gate valves as required.

Extension of the ladder with all valves closed would create a vacuum within the waterway and may cause the sections to collapse. Units with a butterfly valve at the tip have an air intake valve mounted in the waterway at the turntable area to allow air into the system, thus preventing the problem.

Various monitor installations are available, each with or without butterfly valves for regulating the water flow. Manual and/or electrical controls are provided for each monitor function. Optional 2-1/2" and 1-1/2" gated and non-gated pre-connect outlets in the fly section waterway, allow hand lines to be utilized from the tip position, gaining access to otherwise inaccessible areas.

Rated flow through the system is 1000 gpm (3785 1/rn) at a nominal operating pressure up to 250 psi (17.24 bar). The waterway can be charged by the apparatus' onboard pump (if equipped), or through the rear inlet by an alternate supply source. A 0 to 600 psi (41.38 bar) pressure gauge, installed on the aerial control console and/or adjacent to the rear inlet, displays water system pressure. All models are rated to 1250 gpm (4731 l/m) discharge @ 80 PSI or 1000 gpm @ 100PSI aerial discharge in all positions and feature a 0-300 psi (20.69 bar) gage.

#### **Basics of Operation**

In a basic water system, the sequence of water flow begins by actuating the SUCTION control, allowing water to flow from the supply to the booster pump. With the pump engaged, the AERIAL DISCHARGE (waterway charging) control is actuated, supplying the water through the swivel coupling and charging the aerial waterway. The water stream is then directed by the monitor and nozzle assembly, providing elevation, side sweep (slewing), and nozzle pattern selection. (Refer to CAPACITIES AND LIMITATIONS Section for additional information.)

#### AERIAL COMMUNICATION SYSTEM (See Figure 20)

The standard communication system provides two-way conversational capabilities between personnel at ladder tip and aerial control console. Components of the system include: a master control unit installed at the aerial control console, a "talkback" (hands free) speaker unit installed at the tip of the ladder fly section, and associated hardware and electrical wiring. Operating controls are located on the master control unit and provide the following: LISTENING VOLUME, PUSH TO TALK, and TALK VOLUME. An optional three-way system provides a sub-master unit, usually at the pump operator's position.

Several types of communication systems are available employing head sets, cab communications, etc. Details of these systems are included with the communication system.

#### **ROTATION (INTERLOCK) LIMITING SYSTEM**

The Rotation Limiting System works in conjunction with the outrigger/aerial interlock system and will not allow the aerial/turntable to be rotated into an area which is not supported by fully deployed outriggers. An override switch permits use of the aerial with a "not fully deployed" outrigger, but the Rotation Limiting System limits the aerial's movements to the side with the fully deployed outrigger.

#### BREATHING AIR SYSTEM - OPTIONAL (See Figure 21)

The breathing air system offered on Crimson aerial devices provide a filtered, breathable air supply to personnel at the ladder tip. An additional, optional air supply is available at the turntable control console. Major components of the breathing air system include: a 277 cu. ft. (or 400 cu. ft.) air cylinder (second cylinder optional), pressure regulator, shut-off valve, air filter, quick-connect couplings and associated hoses and air fittings. A "low air pressure" alarm system monitors breathing air volume and provides an audible warning when air volume is at or below 20 percent. An optional bar graph style visual gauge is also available for mounting near the turntable console. The bars in the graph loose their illumination as the tanks are emptied.

A 25 ft. refill hose (supplied as loose equipment) enables replenishing of the air supply without removing the cylinder(s) from the apparatus. System pressures of 2250, 4500 and 6000 psi are available depending on customer requirements and options chosen.

END

#### SECTION 2 SAFETY PRECAUTIONS

#### GENERAL

It is not possible to compile a list of precautionary items that would cover every situation encountered when operating an aerial ladder. Therefore, it is the prime responsibility of the officer in charge to oversee fire ground management and to ensure proper use of the aerial apparatus.

Avoiding known hazardous conditions and knowing what corrective action to initiate when unexpected circumstances occur, is the result of proper training and experience. All personnel who work around and/or operate these units shall be trained and certified in all phases of aerial ladder safety, operating procedures, and fire ground management.

With these thoughts in mind, the following precautionary items have been established to assist operators in the proper use of the apparatus.

#### **REMEMBER:**

Your aerial ladder is only as reliable as those who operate and maintain it. A perfect safety record is NO ACCIDENTS.

In addition to the precautionary items in this manual, DANGER and WARNING placards are installed at applicable locations on the apparatus to further illustrate its proper and intended use, and to alert personnel of impending hazards.

#### CAPACITIES

**Learn the Load Capacities of the Aerial.** A Load Chart is installed at the operator's station. It is the responsibility of the operator to study and learn the load limitations of the unit. *However, never rely on memory.* Always refer to your Load Chart while operating the unit.

**Do Not Exceed Rated Load Capabilities.** Regardless of built-in design factors, never exceed published load limitations.

### DANGER

#### Do not rely on apparatus tipping to determine maximum load capacity.

**Evenly Distribute Weight on Ladder.** Personnel on ladder should maintain a distance of 10 feet apart. Load distribution (distance and weight) shall not exceed rated capacities shown on the unit's Load Chart.

#### WARNING DECALS

<u>**Read and Follow All Instructions.**</u> Safety and warning decals have been strategically placed in areas throughout the apparatus in which incorrect or improper actions could cause harm, injury, or mechanical failure if not followed. The following pages show the warning decals that you will see on your unit. Become familiar with each of them so that the information identified will become part of your standard operating procedures.







#### <u>SET UP</u>

<u>Always Apply Parking Brakes.</u> Parking brakes must be applied before outrigger operation is initiated.

<u>Always Use Wheel Chocks.</u> Chocks must be placed ahead of and behind the front steering axle tires. Restraining the front axle provides additional friction to prevent movement (walking) of the apparatus on its outrigger system. This is particularly important when operating on uneven terrain.

**Keep Away From Dangerous Banks and Areas of Uncertain Footing.** Avoid areas such as streams, canals, river banks, and sandy terrain; also use caution when setting up on thawing surfaces. The auxiliary jack pads supplied with the unit are intended for use every time the outriggers are deployed.

### WARNING

•When using auxiliary jack pads under icy or slippery conditions, "rough up" standing surface before placing jack pad under outrigger to prevent sliding condition.

•If load spreader shoring is used, be sure that the material is of adequate strength and size to support the loading imposed by the aerial apparatus.

•Ensure that shoring is properly placed under outrigger jack pad(s) to prevent apparatus from slipping.

•Never set outrigger jack over storm drain or on manhole cover. Also, beams should not "bridge" street and curb.

<u>Always Extend and Set Outriggers Before Attempting Any Aerial Function.</u> Capacities are based on all weight being removed from the vehicle springs, with the load forces being absorbed by the aerial torque box and chassis frame.

All outriggers must be fully deployed (all beams extended to full travel with jacks extended, as necessary, to contact solid, load-bearing surfaces) before aerial is rotated through 360 degrees. All outriggers must be fully deployed (all beams extended to full travel with jacks extended, as necessary, to contact solid, load-bearing surfaces) on one side before aerial can be rotated through 180 degrees on the fully deployed side.

Operating "over the side" requires that the beams on the applicable side of the apparatus be extended to full limit of travel, with the respective jack extended to contact solid, load-bearing surface.

#### **AERIAL OPERATION**

<u>Only Qualified Personnel are Permitted to Operate the Aerial.</u> Do not permit anyone to operate or even approach a control station unless they have been previously trained in the proper operation and application of this apparatus.



You must not operate this apparatus until you read, understand, and can follow all procedures contained in this manual You must Read and understand all DANGER and WARNING placards affixed to the apparatus; be aware of, understand, and can apply the working rules and regulations of your employer and any applicable regulations imposed by government and local agencies.

<u>Never Attempt to Operate Aerial While Mentally or Physically Impaired.</u> Never operate, or even approach, aerial apparatus when under the influence of mind or motor altering drugs (prescribed or otherwise) or alcohol.

<u>Never Get On or Off the Apparatus While it is in Motion.</u> Never get on or off the apparatus (chassis, turntable, or ladder) while it is moving. When getting on or off, use both hands and ensure that your footing is solid.

<u>Never Rapidly Reverse Rotation Directions.</u> "Feather" control lever movement in both directions.



Suddenly reversing swing direction could dislodge personnel, resulting in serious injury, and can cause damage to the rotation system and/or ladder structure.

<u>Never Eat or Drink While Operating Aerial.</u> Always have a qualified relief operator take over your position if you need a break. Eating or drinking at your work station not only distracts from your concentration, it could interrupt control operation if food were dropped or spilled on the console. Also, food or drink spilled on walking and climbing surfaces could make them unsafe.

<u>Never Leave the Apparatus with the Aerial Elevated and Extended.</u> Always retract, lower, stow aerial in the cradle, and shut off power before leaving the apparatus. An elevated and extended aerial tends to fascinate some bystanders who could try to demonstrate their "lack of skill!"

**Keep Constant Eye Contact with an Aerial in Motion.** Always keep your eyes on a moving aerial. Watch for hazards in all directions. If you must look in another direction, stop the aerials operation immediately and smoothly.

<u>Never Use Any Structure to Support the Aerial.</u> The aerial is designed with its maximum strength available in the unsupported configuration. "Reverse loading" introduces component stress, resulting in reduced load capacities. The unsupported (free standing) configuration offers an independent work station in event of structure (building) collapse.

<u>Avoid Positioning Aerial Over Roof to Fight Fire.</u> By avoiding placement of ladder directly over roof area, firefighting personnel and equipment are less likely to be exposed to the everpresent danger of a roof ventilating hazard.

<u>Avoid Rotating Aerial Over Personnel on Ground.</u> Whenever possible, do not swing the aerial over fire ground operating personnel or observers. Loose equipment could fall from the ladder causing serious injury.

<u>Always Wear Proper Protective Gear.</u> Always wear protective clothing and equipment approved by the governing authority when operating the aerial apparatus.

**WARNING** Failure to wear proper protective gear could result in death or serious injury.

#### UNWARRANTED USE OF AERIAL

<u>Never Push or Pull Sideways or Use the Aerial as a Ram.</u> The aerial is not structurally designed for excessive side loading or creation of opposing pressure in the telescoping cylinders. Excessive pressures could cause the aerial to malfunction.

**Do Not Use the Aerial as a Crane.** The aerial is designed to support the weight of approved attachments and accessory equipment (as delivered) and the number of personnel within the distribution and weight restrictions of the Aerial Load Chart. No other application of this apparatus is permitted.

#### ENVIRONMENTAL HAZARDS

Avoid Close Proximity with Electrical Wiring and Cables. Always keep aerial at least 10 ft. (3.0m) away from all wiring. If the aerial should contact power lines, all personnel should remain on the apparatus until power is shut off or aerial is freed. Always assume that power lines and electrical devices are "live."

An important factor in promoting safe operation of Crimson Fire aerial apparatus in an area of overhead energized conductors is for the operator, firefighters, and fire ground personnel to understand the potential of electrical shock hazard.

Electricity in an overhead wire of almost any voltage can cause personal injury and even result in death. Even though the amount of voltage present plays an important part, it is actually the amount of current (amps) passing through the body which determines the severity of injury Voltage is the vehicle which acts as the driving force in pushing the current through a body.

It should be a specific duty of the operator or officer in charge to always be aware of overhead wires and possible contact with them. They should also be ready to warn others on the ground of the impending danger, and advise them to stay away from the apparatus unless their specific duties require otherwise



•Death or serious injury will result from contact with, or inadequate clearance from, energized conductors.

•Maintain safe clearances from power lines and electrical devices.

•You must allow for ladder sway, rock, and sag when operating near power lines and cables.

•The apparatus is not insulated. Contact between the apparatus and ground, should the unit become energized, will result in death or serious injury.

As with all aerial units, firefighting personnel tasked with operating the apparatus should be positioned fully on or fully off the unit. Maintain adequate distances from support cables, guy wires, adjacent water streams, etc., as the aerial could contact, become entangled in, or its movement be obstructed by, such hazards.

<u>Use Extreme Caution When Operating in Windy Conditions.</u> Careful considerations must be given to the following: apparatus supporting surface, aerial profile (elevation, extension, and position relative to wind direction), and the intensity of wind gusts. All of these elements combined affect operating limits. Also, let's not forget the human factor of professional judgment.

#### Beware of "Wind Tunnel Effect" When Positioned Between Buildings with Ladder

<u>Elevated.</u> When operating an elevated ladder in high or gusty wind conditions, be aware that concentrated wind of maximum velocity will be directed at the aerial.

#### WARNING

#### Do not operate with ladder elevated in wind conditions exceeding 45 mph.

**Do Not Allow Snow and Ice Deposits to Form on Aerial.** Snow and/or ice deposits not only create hazardous working conditions, but more importantly, reduce aerial ladder capacities. The aerial is structurally designed for <sup>1</sup>/<sub>4</sub>" of ice distributed evenly along the length of the ladder. Whenever significant ice deposits begin to accumulate on the aerial during inclement weather or water tower operation, clear ladder of personnel, shut down or reduce water discharge, and slowly retract and extend aerial to remove surface accumulation. Remove surface snow and ice from aerial as necessary.

**Keep Mud, Snow, Oil etc. Cleaned From Your Gear.** Clean all foreign material from your footwear before mounting any area of apparatus. Metal surfaces become slippery very easily, and increase the possibility of personal injury with this condition. This precaution is also applicable to gloves. Foreign substances on gloves could cause your hands to slip from handholds and controls, resulting in personal injury or damage to equipment.

#### PERSONNEL ON AERIAL

<u>Position the Aerial Then Climb.</u> Never allow climbing operations during any aerial functions. Do not permit personnel to mount the ladder until the rungs of all sections are aligned for climbing and the RUNG ALIGNMENT indicator light is illuminated.

<u>Never Initiate Extend or Retract Function with Personnel on Ladder.</u> The power available to extend and retract the ladder is more than enough to mangle or sever a limb which may have slipped between the rungs.



Never climb a ladder in motion. Arms and legs caught between moving ladder sections will be seriously mangled or severed.

<u>All Personnel Climbing Ladder Shall Wear a Body Belt.</u> A body belt must be worn when climbing. Secure belt to aerial with a lanyard.



Never use a "leg lock" on the ladder. Legs caught between moving ladder sections will be seriously mangled or severed.



# Failure to wear and secure body belt to ladder could result in serious injury or death.

### DANGER

**Operations at the ladder tip** The (optional) ladder tip controls are utilized to provide the final positioning of the aerial. The tip operator must be belted into position and have his feet firmly positioned on the fold down steps and with the

turntable operator on the foot switch to energize the tip controls. The tip operator's positioned should only be used when absolutely essential for positioning. Extreme care must be utilized to keep feet clear of rungs during ladder extension and retraction.

<u>Avoid Distractions When Climbing Aerial</u> Direct your concentration to climbing and manning your work station. Be especially cautious when climbing at maximum angles of elevation and at maximum ladder extension. Stay alert in windy conditions.

**Expect a Shift in Ladder Position When Changing Direction of Water Stream.** When operating the monitor, expect a shift in aerial position when direction of the water stream is changed. When operating monitor from turntable, alert personnel at ladder tip of intended movement.

#### **ROADING THE APPARATUS.**

<u>Always Completely Stow Outriggers Before Moving Apparatus.</u> Check that the outrigger jacks and beams have been fully retracted before making any attempt to move the apparatus out of position. (Don't forget to retrieve and stow auxiliary outrigger pads.)

<u>Never Move Apparatus Unless Ladder is Retracted and in the Cradle.</u> Do not move the apparatus with ladder in other than the stowed position, as whipping loads can impose undue stresses, resulting in structural damage to the ladder or chassis, or both.

**Do Not Road Apparatus Until All Personnel are Seated and Doors are Secure.** Seat belts are provided for the number of persons authorized to ride the apparatus. Check decal in cab for number of personnel permitted aboard unit.

#### SERVICE AND MAINTENANCE.



•Do not weld, drill, or alter this aerial device unless you receive prior written approval from Crimson Fire Engineering

•Inspect apparatus (chassis and aerial) daily, including all aerial and associated functions. Note and report any conditions found that would render the unit unfit for service and unsafe for operation. (Refer to APPARATUS READINESS CHECKS section.)

Aerial Structure Should Be Tested At Least Once A Year per current NFPA Test Standards and After Any Incident Which May Have Subjected Ladder to Undue Stress. Testing should be performed by an independent agency recognized by the fire apparatus industry.

Keep Oil, Grease, Mud, etc. Cleaned From All Surfaces. Keep work stations, steps, railings, ladder rungs, and handrails, etc. wiped free of foreign substances. Metal surfaces become extremely slippery when oily, greasy, muddy, or the like.

<u>Always Replace Guards and Secure Access Doors and Panels.</u> Immediately replace guards, covers, and secure doors and panels upon completion of inspection, service, and maintenance tasks.

<u>Use Proper Cleaning Solutions.</u> Only use nonflammable solutions approved by the governing authority.

<u>Never Check for Hydraulic or Air Leaks with Your Hands.</u> Hydraulic oil and air under pressure, combined with a pin hole leak, can lacerate skin like a razor. Also, never stick your head in a confined area "looking for leaks."

<u>Strictly Adhere to All Adjustment Schedules.</u> All adjustments must be performed per required schedules, or as otherwise necessary to prevent damage to equipment, or injury to personnel, or both.

#### Stop All Aerial Functions When Lubricating Aerial and Making Adjustments.

Unless a system must be activated in order to perform a specific maintenance task, ensure that all circuits are shut down and secured before initiating any lubricating, adjusting, cleaning, or other required servicing/maintenance requirements.

**Inspect All Cables Pulleys. Guides. and Sheaves Daily.** Never operate with worn, frayed, or partially broken cables, or worn or broken attaching hardware. Replace all damaged components.

<u>Always Check Aerial Finish for Signs of Stress or Damage.</u> Paint will discolor or blister when subjected to intense heat or even after mild heat exposure during prolonged periods. Likewise, crazing or cracking of paint is the result of stressing or cracking of structural members. Obvious deformities, or visible damage should be reported immediately. Evidence of such defects in the shape and finish are cause to submit the aerial to a competent testing agency for a check of structural integrity.

END

#### SECTION 3 CAPACITIES AND LIMITATIONS

#### AERIAL CAPACITIES

DANGER

#### Aerial operating capacities are governed by the Aerial Load Chart installed at the Aerial Control station. Any deviation from these rated capacities could cause death or serious injury and/or structural failure of the aerial.

As the operator of an aerial ladder, the well-being of various personnel rests with your performance skills and ability to make proper judgments "on the spot" as conditions demand. These factors make it all the more imperative that you are not only aware of your limitations, but also aware of the physical and structural limitations of the apparatus.

Some of the following limitations appear on the Aerial Load Chart and are repeated here for informational purposes only.

### DANGER

## When operating elevating platform, refer to Aerial Load Chart for rated capacities and related information. *Never rely on memory!*

1. Load capacities are established at maximum permissible extension and operation throughout 360 degrees, with outriggers fully extended and set, turntable level (within 6%/3.5 degrees), waterway drained, and with the aerial ladder unsupported.

2. Full, rated capacities are allowable when turntable is level on grades up to, but not including, 6% (3.5 degrees). On grades where turntable is out of level between 6% and 14% (3.5 and 8.0) degrees, capacities are reduced by 50% (one-half).

3. Wind, ice, and other factors affecting stability, as well as strength of supporting surfaces and skill of the operator, must be considered when utilizing the aerial at its fullest potential.

4. Certain capacities are limited by structural integrity, therefore, stability factors (as evidenced by apparatus tipping) must not be relied upon as the capacity limitation.

5. Reduction in load capacities must be made to compensate for ice and/or snow accumulation. Base design is based on <sup>1</sup>/<sub>4</sub>" of ice uniformly distributed over the aerial.

6. Capacities are established for unit based on typical unit configuration. Substitution and/or addition of non-standard equipment may void all warranties and invalidate any liabilities.

### WARNING

Aerial Ladder Capacities are established with a 125 lbs of additional equipment at the tip allowance (other than "as delivered" items). The weight of tip equipment in excess of this allowance must be deducted from tip load capacities.

#### **READING YOUR LOAD CHART**

The Load Chart presents a graphic display of the aerial ladder apparatus' load lifting and weight distribution limitations. The chart is representative of both ladder and water tower operational capacities, as well as combined operational capacities. Basic operating precautions and emergency shutdown instructions are also included on the chart as applicable.

When used with the aerial elevation indicator, the Aerial Load Chart enables the operator to determine the rated load capacity of the aerial under specific load conditions.

# **WARNING** The only applicable load limitations and capacities are those appearing on the Aerial Load Chart attached to the apparatus. DO NOT use any other ratings unless approved, in writing, by Crimson Fire

#### GENERAL NOTES TO CAPACITIES AND LIMITATIONS

- 1. All capacities are based on outriggers set with extension beams at maximum stroke. The unit's weight should be removed from the chassis springs, rear tires off the ground, front (steering axle) tires chocked and maintaining ground contact.
- 2. Published capacities are permissible where turntable is level within 3.5 degrees. Where the turntable is out of level in a range from 3.5 degrees up to 7.0 degrees, capacities must be reduced by 50% (one-half). Operating where the turntable is out of level in excess of 7 degrees is not recommended.
- 3. Certain capacities are limited by structural safety factors, therefore, tipping cannot be relied upon as a load limitation.
- 4. Capacities are determined for apparatus based on standard unit configuration. The weight of any additional equipment (hose, ladder, axe, etc.) must be deducted from rated capacity.

#### WATER TOWER CAPACITIES

# DANGER

# Operating capacities are governed by the Aerial Load Chart installed on the apparatus. Any deviation from these rated capacities could cause death or serious injury and/or failure of the aerial.

Keep in mind that capacities for water tower operation are in addition to (combined with) those for aerial ladder operation. Therefore, one must be thoroughly familiar with the ladder's load limitations before attempting any water tower operations. (Refer to Aerial Ladder Capacities in this section.)

Many of the basic water tower operating rules are based upon reactive force, i.e., the force created at the nozzle (in relation to pressure, flow, and the size and type of nozzle opening) and transmitted to the aerial structure. This is the same as the force transmitted to the operator when manning a hand-held line.
Some of the following items also appear on the Aerial Load Chart and are repeated here for informational purposes only.



\*\* RATED DISTRIBUTED LOAD CAPACITIES ARE IN PLACE OF (NOT IN ADDITION TO) RATED TIP LOAD CAPACITIES \*\*

#### - WATER TOWER CAPACITIES -

AERIAL ELEVATION	FLOW	NOZZLE POSITION (SEE DIAGRAM)
-10 DEG TO 75 DEG	1000 GPM	UNLIMITED NOZZLE POSITION

#### **GENERAL OPERATING GUIDELINES**

-DANGER- THIS APPARATUS IS NOT INSULATED. DEATH OR SERIOUS INJURY WILL RESULT FROM CONTACT WITH, OR INADEQUATE DISTANCE FROM ELECTRICAL POWER LINES OR ENERGIZED CONDUCTORS.

- DO NOT OPERATED THIS AERIAL WITHOUT PROPER OPERATIONAL INSTRUCTION.
- ۶ READ AND FULLY UNDERSTAND THE OPERATORS MANUAL BEFORE OPERATING THIS APARATUS. ۶
- READ AND FULLY UNDERSTAND ALL INSTRUCTIONAL AND SAFETY DECALS ON THIS APARATUS.

Figure 4 Load Chart - Example

### WATER TOWER CAPACITIES (CONT'D)

### **WARNING** When operating the water tower, refer to Aerial Load Chart for rated capacities and related information. Do not rely on memory!

1. Water tower/load capacities are established with outriggers fully extended and set, turntable level (within 6 %/3.5 degrees), and the aerial unsupported.

2. Know your capacities. Study this manual and the Aerial Load Chart. Verify all load limitations before initiating any operation.

3. All aerial functions, except swing, may be performed simultaneously with water tower operation. Movement of the nozzle and aerial should be slow and deliberate.

### **WARNING** Do not swing aerial to position water stream. Rotate monitor to redirect stream.

- 4. Snow and ice deposits beyond <sup>1</sup>/4" of uniform ice loading require reducing capacities due to excess weight.
- 5. A qualified operator must remain at the turntable control console during water tower operations.

END

### SECTION 4 CONTROLS AND INDICATORS

### GENERAL

The information contained in this section is based on the most common installations. Since some control and indicator arrangements are subject to customer specifications, location of specific items in the descriptive text is typical. Your familiarization with the physical configuration of your unit will assist you in determining the applicability of the controls and systems covered in this manual.

NOTE: References made to left, right, front, and rear when referring to the aerial are those directions viewed when standing at heel pin looking toward the ladder tip (ladder cradled).

### PRIMARY CONTROLS - TYPICAL

### **Apparatus Battery Switch (Optional)**

Some units utilize a rotary-type BATTERY SELECTOR SWITCH in the apparatus cab. The switch permits selection of two battery circuits which should be used alternately. Some switches have a "both" position. We recommend that you do not use this position because of potential damage possible to second circuit if the other circuit is already damaged. Units without this switch usually employ an ignition on/off switch which will also make the necessary battery connection.

NOTE: It is important that after the ignition or battery switch has been turned to the OFF position, the switch must not be turned back to the ON position until the engine has stopped completely.

Consult chassis manual for proper start-up and shut-down procedures for your particular unit.

#### Power Take-Off (PTO) Control

A PTO control switch is installed in the apparatus cab, usually on the main control panel. An indicator light on the switch illuminates when the switch is positioned to "on." Activating the switch energizes a solenoid which allows transmission fluid to the PTO. A clutch within the PTO engages the shaft which transfers power to the hydraulic pump. The truck transmission must be in the neutral position, and the parking brake set, before engaging the PTO.

#### Power Take-Off Engaged Indicator Lights

A pressure switch mounted on the PTO senses pressure inside the PTO and energizes a light adjacent to the PTO Switch.

#### Ladder Power Switch (optional)

A lighted Ladder Power switch is provided on the apparatus cab dash or on an auxiliary switch panel. When the switch is positioned to "on," a relay is energized which connects electrical power from the batteries to aerial circuits.

### ENGINE CONTROLS AND INDICATORS - TYPICAL.

### Fast Idle Switch

On rear mount models, FAST IDLE switches are also located at the aerial control station and at both outrigger control stations. Tractor Drawn models have switches at the left and right hand outrigger control station. These systems require that the transmission be in neutral and the parking brake set before they are operational. (Optional.) A rocker-type, single-throw HI-IDLE switch is installed on the master switch panel in the chassis cab. These controls are used to maintain higher RPM values for lighting and other auxiliary devices. When actuated, circuitry is completed to provide a preset "fast idle" engine speed (typically 1200-1500 rpm).

### <u>Hourmeter</u>

A 12-volt dc hour meter, installed in the apparatus cab, records operating hours with the power take-off engaged (which translates to aerial hours of operation).

### Hand Throttle

Units with a fire pump often utilize a vernier type, hand-throttle installed at the pump operator's position. Although the hand throttle is a mechanical device, on most units it actuates an electronic control module (ECM) which controls engine speed. Some units still use all mechanical linkage to control engine speed. When the water pump is actuated (transmission is in pump mode) the aerial fast idle circuit is automatically disabled. During fire pump operation the optimum operating speed can be regulated with the hand throttle. To raise engine speed, turn knob counterclockwise, and lock by turning Lock Collar clockwise (counterclockwise to release). Emergency slow down of engine can be achieved by hitting the Red Button on the end of control.



### **OUTRIGGER CONTROLS AND INDICATORS - REAR MOUNT.** (See Figure 5)

#### **Outrigger Systems**

Rear mount 103' Crimson Aerials utilize non-extendable front outriggers and X-Style rear outriggers. This combination of outriggers provides a wide range of truck leveling capabilities (up to 15 deg) and increased flexibility of deployment due to the reduced foot print of system.

### Front Outriggers

The front outriggers are mounted directly behind the cab and are non-extendable. They are angled at approximately 5 degrees to provide a 9'-6" stance at the front. This outrigger provides a narrower base for setting the truck up in congested areas where placing two sets of outriggers is difficult. The front outriggers have a cross tube integrated with the chassis frame and torque box with a bolt-on outrigger housing and cylinder. The cylinders are mounted in an inverted position

(rod up) and can be easily serviced. The outrigger foot has a multi-axis pivot plate for setup on slopes.

### Rear Outriggers (X-Style)

The X –Style rear outriggers consist of an outrigger beam, outrigger jack cylinder, and a pivoting outrigger beam housing. The outrigger beam housing can pivot 10 degrees downward from the stored position by deploying the outrigger leveling cylinder. With the beam fully deployed, the outrigger leveling cylinder provides 2 to 3 degrees of leveling without deploying the jack cylinders at all. The outrigger jack cylinder provides an additional 24 inches of ground penetration after the leveling cylinder is deployed. The total truck leveling range of the X-Style system is 14 to 15 degrees dependent on frame height.

### **Extension/Retraction Controls**

Control of the outrigger system is provided at the two Outrigger Control Stations at the right and left rear of the truck. Three handles at each location provide joystick control of the valves which direct hydraulic flow to the required cylinders for deploying and stowing outriggers. The outrigger control stations provide color coded identifiers for each outrigger.

The dark blue control section is for the angled front outriggers which do not have extendable beams. Their only motion is up and down. Pushing down on the handles will respectively lower the outrigger jack (vertical) cylinders. Pulling up on the handles will raise the outrigger jack cylinders.

The light blue control section is for the rear outrigger beams. The dual axis joy stick directs the motion of the outrigger beam and housing. Pushing outward horizontally on the joystick will extend the beam from the housing. Pushing down on the two axis control will lower the outrigger housing.

Pulling horizontally inward will retract the beam and pulling up on the joystick control will raise the beam. The single axis joy stick controls the movement of the rear outrigger jack. Pushing down on handle will lower the outrigger jack (vertical) cylinders. Pulling up on handles will raise outrigger jack cylinders.

Simultaneous multiple functions may be achieved by actuating two functions, but individual outrigger speeds may be reduced. Handles are located to allow operator to see outrigger movement throughout the entire path of outrigger travel.

### **OUTRIGGER CONTROLS AND INDICATORS - MID MOUNT/TILLER MODELS.**

All of the TL Series tillers utilize a direct hydraulic control system for normal outrigger operation. (Figure 6.) An outrigger control box is mounted on each side of the unit in close proximity to the outriggers.

Mid mount units have control boxes on both sides of the unit. Controls for each outrigger function are located in each outrigger control box.

### **Outrigger Emergency Controls**

All tractor drawn and mid mount units utilize a manual valve bank for control of the outriggers. Therefore, these units do not have separate emergency/manual controls. Other RL Series aerials have emergency/manual controls which allow operation of system functions if electrical control box is not functional. (See Outrigger Operation Section for emergency/manual control procedures.)

### **Outrigger Fully Deployed Indicator Lights**

Working in conjunction with the outrigger interlock system, each outrigger has limit and proximity type switches which must be activated before the aerial can be operated. Switches activate when outrigger beams are fully extended and the jack cylinders are properly deployed. When all switches are activated for a particular outrigger, its green light at the control box will light.

### Aerial/Outrigger Circuit Pressure Gauge

A 0 to 5000 psi (0 to 345 bar) pressure gauge is piped directly into the hydraulic system interlock valve manifold near the outrigger control valves bank. The gauge shows selected circuit operating pressure when either the aerial or outrigger system is activated. The gauge is located near the R.H. outrigger control station.



### Figure 5 Outrigger Control and Indicators, Rear/Mid Mount

#### **Rotation Interlock System**

Outriggers jacks can be lowered to the ground without the beam (horizontal) cylinder being in its fully extended position. This is identified as a "short-set" condition which will reduce the safe movement of the aerial. (See Outrigger Interlock Override in the Outrigger Operation Section).

NOTE: Although this system does limit the unit's movement into an unsafe area, Aerial movements must be monitored by the operator as a precaution.

### Manual Circuit Selector Valves

In the event of an electrical failure, the outrigger controls could become disabled. The circuit selector valves requires that the knob to be pulled out and continuously deployed. When activated the manual circuit is selected it allows hydraulic fluid to the outrigger valve bank which can then be controlled using standard operating procedures. (See Outrigger Interlock Override-Manual Controls in Outrigger Operation Section for procedure.)

### **Emergency Power Unit (EPU) Switch**

A hydraulic failure within the main system could stop normal operation of the outriggers. An Emergency Power Unit with controls at each outrigger control station can be used in conjunction with outrigger function levers and override controls, if necessary, for brief emergency operation of required systems. (See EPU Operations)



### Figure 6 Outrigger Controls and Indicators, Tractor Drawn

### TILLER CONTROLS AND INDICATORS. (See Figure 7 and Figure 8)

### Air Circulating Fan - Optional

An air circulating fan, bracket-mounted above the left side window (top, forward corner), provides additional air flow inside the cab. The fan is controlled by an integral on-off switch on its base.

### Heater/Defroster Control - Optional

The control unit for the heater/defroster is mounted to the far right of the dash panel. It features an on/off switch for the internal fan and a numbered control dial for setting desired heat levels. The louvered exhaust shroud, located at the top, right side of the dash, can be positioned to direct the heated air flow, as desired. The heater/defroster requires a three minute cool-down period after being turned off, to dissipate residual heat.

### **Turn Signal Indicators**

Left and right turn signal indicator lights are installed on their respective sides of the roof mounted panel. The indicators are connected in parallel with the apparatus cab turn signal system and function to alert the tillerman of the direction of travel.

### **Audible Warning System**

An audible (buzzer) warning system permits the tillerman to signal the apparatus driver and vice versa. The foot-operated control switch is installed on the cab floor, to the left of the steering column. Standard signals are: 1 (audible) STOP, 2 (audibles) GO, and 3 (audibles) BACK UP. The same type of control is installed in the apparatus cab, allowing the driver to signal the tillerman.

### Windshield Wiper Control

A WIPER control is located on the right side of the tiller cab dash. Actuating the switch activates the wiper assembly on the front windshield.



**Figure 7A Tillerman Controls and Indicators** 

### **Driving Lights Switch - Optional**

Driving type lights which can be mounted in the rear steering axle area may be controlled from the tiller cab by a switch provided on the dash. Lights are designed to illuminate tire pathway and aid the tiller driver to determine clear paths to the right or left

### **Engine Start/Enable Switch**

This switch must be depressed in order for the truck engine to start. This prevents the driver from pulling away without a tillerman in the seat.

### **<u>Tiller Axle Wheel Position Indicator</u>**

An indicator is provided to show the alignment of the wheels on the tiller axle with the trailer frame. This provides a visual display to the tillerman to show the direction his wheels are facing when he is in the tiller cab.

### <u>Tiller Jackknife Alarm</u>

An alarm and light are located in the tiller and drivers cab to warn the operator when the tractor and trailer are approaching a 90 degree angle and possible collision. The driver should stop immediately when this alarm sounds.



**Figure 8B Tillerman's Controls and Indicators** 

### **Auxiliary Interior Light**

A dome type light with switch is supplied to provide additional lighting for the cab interior. Light is mounted behind and to the left of the tillerman.

### **Mirrors**

Adjustable mirrors are provided for the convenience of the tillerman. These mirrors allow for inout and up-down adjustment for rear visibility.

### **Tiller Cab Air Conditioning - Optional**

The system consisting of a compressor, condenser, evaporator/blower, thermostat, and an air dryer complete the list of major components. Controls are mounted on the tiller cab dash and allow control of fan and temperature. This system is power by the 110VAC system independent of chassis air conditioning.

### **<u>Communication – Optional</u>**

When equipped with a communication system, it is possible to speak to other personnel elsewhere on the unit, usually in the driver's cab. Various systems are available, with options such as three-way communication and/or hook-ups for headsets.

### <u>Horn Switch</u>

A standard horn button is supplied in the center of the steering wheel which when pushed activates horn speaker located at front of apparatus cab.

### Fresh Air Vents(Optional)

Four, manually-operated, adjustable vents can be provided for the tiller cab. Two vents are located on the cab back wall on either side of the seat, and one vent is located in each foot well, on the cab side panels.

### Seat Belts

The tillerman is provided with a seat belt which must be used whenever the vehicle is in motion.

### AERIAL CONTROL CONSOLE (See Figure 9)

A control console, dedicated primarily to aerial functions, is installed on the left side of the turntable for rear mounts and the left side for TDA's when viewed from the tiller cab. Aerial controls and indicators located at the console are described in the following text.

### Aerial Power Foot Switch

A foot-operated aerial power switch is installed on the turntable deck at the control console. The operator must depress and hold the switch in the "ON" position to operate the aerial from the console. Should the operator become immobilized, or leave the assigned station (foot switch no longer actuated), the aerial would immediately become inoperable from the console.

### Aerial Controls and Indicators (See Figure 9)

Aerial function control levers are mechanically linked to the valve spool. Therefore, when the lever is actuated the spool is shifted (moved) proportionally to control lever movement. The travel distance to actuator response, is proportional to control lever movement.



### **Elevation Control Lever**

The ELEVATION control lever, located to the right of the Rotation control, permits raising and lowering of the aerial when positioned to RAISE or LOWER

### **Rotation Control Lever**

The ROTATION control lever, located between the telescope and elevation controls, permits rotation of the aerial in the desired direction when positioned to LEFT or RIGHT.

### **Telescope Control Lever**

The TELESCOPE control lever, located to the left of the rotation control, affords extension and retraction of the aerial ladder when positioned to EXTEND or RETRACT.

### Lever Locations

Control levers are located as follows: Telescope- Left Side Rotation - Center Elevation - Right Side

### **Rung Alignment Indicator**

An amber RUNG ALIGN(ment) indicator is installed to the right of the aerial control console on the ladder lift cradle. The light illuminates when the rungs of all ladder sections are properly aligned for climbing.

### **Aerial Extension Meter**

The extension meter is located on the base section hand rail of the aerial. The handrail has a numerical display of LADDER EXTENSION in 10 foot increments. Used in conjunction with the

load chart and aerial elevation indicator, the ladder length information enables the operator to determine the rated capacity at the given length and angle of elevation. Optionally, ladders may be equipped with a numerical display on or near the control console which provides the ladder extension in feet.

<u>Aerial Elevation Indicator</u> A floating ball-type angle indicator is installed on the left side of the ladder base section at the turntable. The indicator is calibrated from -20 to 80 degrees. Used in conjunction with the load chart and the extension meter, the indicator enables the operator to determine the rated capacity at the given angle and length.

**Fast Idle Switch** A FAST IDLE Switch is installed on the Aerial Control Console and on the both Outrigger Control Panels. Actuating the switch automatically selects the preset "fast idle" engine speed, provided that the transmission is neutral and parking brakes are set. Fast idle is also disabled when fire pump is in gear.

<u>Monitor and Nozzle Controls</u> Three switches located on the right side of the console face allow remote control of the monitor and nozzle. A second control box is mounted on the sliding/retractable monitor mount. Switches are allotted for control of nozzle SWEEP (right and left), ELEVATION (up and down), and PATTERN (fog or stream).



### When the monitor's retractable mount is pinned to mid-section, the monitor must be operated with controls at aerial console.

NOTE: Depending upon the monitor configuration, switches at turntable console may override controls installed on the monitor's retractable mount. (Refer to monitor Operator's Manual.)

<u>**Cradle Alignment Indicator**</u> An indicator (green) is provided on the ladder lift cradle, to identify that the ladder is properly aligned with the cradle for storage.

<u>**Outrigger "Not Deployed" Indicator**</u> A red light located at each aerial control station indicates that an outrigger has not been fully deployed, and that a "short-set" condition exists.

<u>**Outrigger Interlock Override**</u> When it has been necessary to "short-set" an outrigger, the "Not Deployed" indicator will be lit and it will be necessary to use the Outrigger Interlock Override control to move the aerial.

WARNING

Improper use of the Outrigger Interlock Override Switch, or use by an improperly trained operator, could lead to a seriously unsafe situation.

<u>Water Flow Meter</u> If the unit has a pre-piped waterway, a water flow meter is required so that the flow can be monitored. A digital display supplies a continuous read-out of the gallons per minute (GPM) of water being discharged through the aerial's telescopic waterway and nozzle. This system consists of a sensor in the waterway piping, an electronic module, and the display unit.

<u>Aerial Waterway Preconnects - Optional</u> Preconnects located in the fly section waterway are designed to allow hand lines to be used from the tip position. A butterfly valve in the waterway mounted ahead of the monitor stops flow to nozzle and diverts water to the preconnects.

<u>Communication Station</u> A two-way communication system consisting of a master station at the turntable control station or pump panel area and a slave station mounted at the tip, allow communication between operators at each station. Other configurations may include a third station for three-way communications or hook-ups for headsets. Station at tip allows "hands free" talking and listening. Specific communication system details are available from component manufacturer's specifications

Low Air Pressure Alarm (required when breathing air is supplied) Units that have an optional breathing air system also feature a low air pressure warning alarm which provides an audible signal to the users that the volume of breathing air in the system is at or below 20 percent. Optionally, the system can be provided with a gauge mounted near the turntable console which gives a visual representation of total air tank volume and indicates reduced levels as the air is used.

Low angle load Alarm Indicator(optional). An optional alarm system is available which will indicate that a preset limit of loading on the aerial has been reached. The system determines the hydraulic pressure within the lift cylinder circuit. At low elevation angles, as the load is increased on the ladder the pressure in the circuit will also increase until the limit is reached, The load alarm provides a bar graph display of this pressure and sets off an audible alarm when the maximum is reached. This system is to be used as a secondary system of warning due to its inaccuracy when the unit is at higher elevations. At higher elevations the loads shift from the lift cylinders to the extension/retraction cylinders and their associated cables. The limitations identified on the load chart for a particular unit are to be strictly followed to ensure safety for personnel and equipment.

### WARNING

#### Do not load the aerial past the limitations identified on the Load Chart. Overloading of the aerial can cause equipment failure and death or serious injury to personnel.

**Rotation Limiting System** (See Figures 45 and 51.) Units equipped with the Rotation Limiting System have an added degree of safety, because rotation of the aerial/turntable has been restricted to the side opposite of a "short-set" outrigger. The system does not allow movement of the ladder to positions past parallel to the truck and on the same side as a "short-set" outrigger.

### DANGER

### Movement of the aerial/turntable to positions past parallel to truck or on the same side as a "short-set" outrigger will cause unit to tip over. *Do not under any conditions move aerial to the prohibited positions*.

The Rotation Status lights on the aerial control console identifies that the outriggers are "short-set". The aerial will not be allowed to rotate to the short set side. When the aerial nears the restricted area, the aerial movement will be stopped hydraulically. Do not move the aerial to the same side as a "short-set" outrigger even if the controls will allow you to do so. Report any suspicion that the system may be operating improperly.

### MANUAL OVERRIDES/EMERGENCY CONTROLS - AERIAL. (See Figure 45.)

Crimson aerial ladders do not have manual override controls as such. The aerial valve bank is located inside the turntable console. The control handles located on the console are directly moving the valve spools inside the valve bank, and shifting the hydraulic fluid as the handles are moved.

In the event of an electrical failure, it will be necessary to actuate the blocking solenoid valve located at in the outrigger control area. To perform this operation, two people are required. To actuate the valve, pull knob and hold. Fluid flow is now possible to the main aerial control valve. The second person operates the required aerial functions at the turntable. The aerial may also be used as absolutely necessary for rescue procedures. The electrical problem must be corrected as soon as possible. When aerial stow procedure is complete, release the knob.



## With blocking solenoid disengaged, aerial must be used in accordance with limits defined by the outrigger set-up (aerial must not be used on the same side as a "short-set" outrigger).

NOTE: Restore solenoid knob to its original position before outriggers are moved.

Use of the EPU (Emergency Power Unit) will be required if a hydraulic failure has occurred. The momentary switch, located at the outrigger control stations and optionally at the aerial control station, must be held ON to provide fluid flow to aerial systems. Only limited functions needed to wrap-up the unit are suggested because of the short continuous use time of the EPU. (See Emergency Power Unit Section.)

### SECTION 5 APPARATUS READINESS CHECK

### **OPERATOR'S DAILY CHECKLIST.**

The following "checklist" items are to be used in conjunction with the Walkaround Inspection Diagram during daily, operational readiness checks of the apparatus. Inspecting personnel should be especially alert for evidence of structural damage, loose equipment,



leaks, and any other conditions that would require immediate corrective action to keep the unit in a "state of readiness."

### **Fuel Supply**.

Check that fuel (diesel) supply is adequate and fill cap is secured.

**Figure 10 Fuel Supply** 

### Tires and Wheels.

Inspect all tires for severe cuts, foreign objects imbedded in treads, uneven wear patterns, and proper inflation. Inspect all wheels for being "out of round," and for cracks and other visible

damage. Inspect all wheels for loose and missing lugs. (Refer to chassis manual for chassis' wheel lug torque requirements.)



Figure 11 Tires and Wheels



### Engine Oil Level.

Check oil level in crankcase. Fill to proper level on dipstick. Refer to engine manufacturer's specifications. DO NOT OVERFILL.

Figure 12 Engine Oil Level.



### Batteries

Check batteries for proper electrolyte (fluid) level. Inspect cables for security, visible damage, and corrosion. Add only clean, distilled water. AVOID OVERFILLING.

**Figure 13 Battery** 

#### Engine Coolant Check coolant level in radiator; fill to proper level. DO NOT OVERFILL. (Refer to chassis' manufacturer's instructions.) Inspect radiator for evidence of leaks, visible damage, and hoses and fittings for security.



**Figure 14 Engine Coolant Level** 



### **Emergency Signals**

Inspect all lights, sirens, flashers, signals, etc. (both chassis and aerial) for proper operation. Inspect all associated hardware for visible damage. Replace defective bulbs with those of same number or equivalent.

### Figure 15 Emergency Signals

### Hydraulic Oil Reservoir

With all systems shut down (outriggers retracted; aerial retracted and bedded), check oil in reservoir. Fill to FULL mark on temp/level gauge. Also, check return line filter element indicator for "bypassing" condition. Replace element as necessary.

NOTE: Reservoir will never read completely full after a cylinder has been deployed.



SIGHT/LEVEL<sup>2</sup> GAUGE



### Pinion and Turntable Bearing.

ROTATION BEARING GEAR

**Aerial Control Console** 

Inspect drive pinion and turntable bearing gear teeth for visible damage, proper meshing and alignment, evidence of wear, and adequate lubrication. Inspect turntable bearing bolts for visible damage and security (loose and/or missing).

> WARNING LIGHT

SHORING <sup>·</sup> PAD

Inspect control console components for visible damage, security, and applicable controls for freedom of movement. Inspect all electrical connections for visible damage and

### **Outriggers**

Inspect overall outrigger installation for visible damage, evidence of leakage, chafed hoses, and sliding beams for scoring. Inspect outrigger warning (flashing) lights and work lights for security, frayed and broken wiring, and visible damage.

security.

Figure 18 Outrigger



Figure 19 Aerial Control Console

### **Communication Systems**

Check system for proper operation. Inspect master unit (at turntable console) and tip unit (on ladder fly section) for visible damage, loose and/or missing parts, and security.



**Figure 20 Communication System** 



### **Breathing Air Supply – Optional**

Check system for proper operation. Inspect tanks, regulator, gauges, and hoses for visible damage, loose and/or missing parts.

A visual display with flashing lights and audible warning alarm is provided to indicate that the volume of air in the tank below 20% of full.

**Figure 21 Breathing Air Supply** 

### Ladder Extension/Retraction Systems

Inspect ladder extension/retraction cylinders for visible damage (barrels and rods), evidence of leakage, and security. Inspect all running cables (wire rope) for evidence of corrosion, more than one broken wire in any one strand, excessive wear and/or broken wires near sheaves, noticeable reduction in rope diameter, any other mechanical damage affecting rope structure, and cracked, bent, worn, or improperly installed end connections (termination points). Inspect sheaves, guards, guides, etc., and any of the surfaces that may contact the wire rope for any defect that could affect the integrity of the rope.



Figure 22 Ext/Ret. Systems



Figure 23 Lift Cylinders.

### Inspect ladder lift cylinders (barrels and rods) for

visible damage, evidence of leakage, and security. Inspect connection points for loose and/or missing hardware.

CYLINDERS

LIFT



**Figure 24 Ladder Sections** 

### **Aerial Ladder Sections.**

Visually inspect individual ladder sections (ladder extended horizontally) for overall structural integrity, visible damage, proper alignment, attachments for loose and/or missing parts, and hardware for security.



Figure 25 Rung, Covers & Clips



### Aerial Waterway.

Inspect aerial waterway for visible damage, alignment, security and proper lubrication. Inspect all waterpipe connections above and below turntable for visible damage and security.

SEALS & LUBE FITTINGS

WATERWAY



**Figure 27 Fly Section** 

Figure 26 Aerial Waterway.

### Fly Section Storage.

(For aerials with storage provisions at tip of fly section.) Inspect all equipment for visible damage, security, and loose or missing hardware. Verify that all required items are accounted for.



### **Monitor and Retractable Mount**

Inspect monitor for visible damage, loose or missing hardware, security, proper lubrication, and mounting flange for security. Inspect drive motors for visible damage and security. Inspect electrical connections at both fly and mid section for alignment and security. Inspect retractable mount for visible damage, loose or missing hardware, and mount for security.

Figure 28 Monitor and Mount

**Foot and Parking Brakes** Check foot and parking brakes for proper operation.



Figure 29 Foot & Parking Brakes



### **Power Take-Off/Pump Controls**

Inspect PTO and pump controls and indicators in cab for visible damage, loose or missing parts, and applicable items for operation.

Figure 30 PTO/Pump Controls.

### Pump Operator's Panel

Inspect overall pump panel for visible damage, and loose or missing parts. Check all controls and indicators for serviceability and applicable controls for freedom of movement. Check that all caps, covers, plugs, etc. are installed and secure. Check that all applicable controls were returned to proper positions after last fire call or test.



Figure 31 Pump Operator's Panel



5<sup>TH</sup> WHEEL PIN & RETAINER

### **Fifth wheel Pivot Pins, Lock Cylinders, Bearing, Weldments and Attaching Hardware** Inspect 5<sup>TH</sup> wheel pins and attaching hardware for

Inspect 5<sup>TH</sup> wheel pins and attaching hardware for security, bearing for loose or missing bolts and washers, 5<sup>th</sup> wheel lock cylinders for loose or missing attachment bolts, and bearing weldment to chassis attaching bolts for security (loose or missing).

Figure 32 Fifth Wheel & Bearing

CYLINDER 5<sup>TH</sup> WHEEL BEARING & ATTACHMENT

BOLTS

5<sup>TH</sup> WHEEL LOCK

### **Steering Pump Reservoir.**

Check fluid level in reservoir. Fill to proper level. DO NOT OVERFILL.

NOTE: Steering pumps on most tiller models are integral (in tandem) with the tractor steering pump and are supplied fluid by the power steering reservoir.



Figure 33 Walk-A-Round Inspection Diagram, Rear Mount



Figure 34 Walk-A-Round Inspection Diagram, Tractor Drawn



Figure 35 Walk-A-Round Inspection Diagram, Mid Mount

### SECTION 6 SET-UP PROCEDURES

### PRIORITY CONSIDERATIONS FOR SETTING UP

Rescue capability is always the primary concern when positioning the apparatus for operation. With proper training and experience gained from previous fire ground operations, such assessment and action should become instinctive in nature.

Upon arrival at the fire scene, the following factors must be taken into consideration prior to positioning the aerial ladder apparatus for use:

# **WARNING** Due to the overall length of the aerial, it is most important to position and set up the apparatus to the best advantage of existing conditions. Avoid any situation which could deteriorate and result in apparatus tipping, overloading the ladder, subjecting the aerial to contact with charged conductors, or any other known hazardous environment.

- 1. Required reach and intended use of aerial.
- 2. Ground conditions and slopes affecting stability.
- 3. Overhead obstructions and hazards.
- 4. Conditions favorable to operating "over the rear." ("Over the rear" operation is defined as angles up to and including 45 degrees to either side of the apparatus centerline. "Over the rear" affords the most stable operating position for the aerial. Greatest reach is also gained with the aerial positioned "over the rear.") Note: A minimum of a 1.5 to 1 stability factor is achieved in all orientations of the ladder with respect to the truck.
- 5. Accessibility to onboard equipment.
- 6. Existing fire, fire ground conditions, and those likely to develop.
- 7. Not obstructing approach or exit, or otherwise interfering with simultaneous fire ground operations.

### **PREOP REQUIREMENTS – AERIAL APPLICATION ONLY**

1. Position apparatus in best possible location, keeping in mind that operating "over the rear" offers maximum stability.

2. With engine at slow idle (600 rpm approx.) and apparatus transmission in neutral, set parking brake and chock front steering axle wheels (in front of and behind tires).

- 3. Shift apparatus transmission to N (neutral). Depress clutch on units with manual type transmission.
- 4. Engage PTO, as applicable.
  - a. Hot Shift PTO, (Automatic Transmission) with engine at slow idle (600 rpm approx.) and transmission in N (neutral), actuate PTO control switch. This energizes a solenoid, opens a valve, and allows transmission oil pressure to engage a clutch pack integral of the PTO. Check that PTO Engaged light is illuminated.
  - NOTE: Most apparatus with automatic transmissions are equipped with an electrically-actuated PTO, Hot Shift type.
    - b. Mechanically-engaged PTO, (Automatic Transmission) with engine at slow idle (600 rpm approx.) and foot brake applied, position transmission range selector in gear, and engage PTO by shifting lever for Air-type actuator or by pulling knob for Cable-type actuator. Transmission can now be placed in neutral.

### Do not attempt engaging PTO in neutral as gnashing of gear teeth could result in severe damage to PTO and/or transmission.

- c. Mechanically-engaged PTO, (Manual Transmission) with engine at slow idle (600 rpm approx.) and clutch depressed, PTO can now be engaged by shifting lever or pulling knob depending on actuator type.
- NOTE: If proper gear mesh or engagement is not completed, it will be necessary to reset actuator. With brake depressed, let clutch out slightly to advance gear positions. Depress clutch again and reapply PTO actuator.
- NOTE: The above listed transmission/PTO type combinations are by far the majority of systems currently in use on this type of apparatus. There are, however, units that may not conform to the above procedures. If there is any question about procedure on your particular unit, please consult the Crimson Fire factory, the chassis manufacturer or PTO manufacturer for information on correct procedure.
- 5. Actuate Fast Idle switch at outrigger control station or hand throttle on units so equipped, to set engine RPM at required speed for outrigger operation.
  - NOTE: Aerial Fast Idle system will not work unless the parking brake is set and the transmission is in neutral.
- 6. Set outriggers as required (Refer to Outrigger Operation Section).



Figure 36 Electric Pump Shift Controls

### PREOP REQUIREMENTS - FIRE PUMP APPLICATIONS ONLY

Position apparatus in best possible location. It may become necessary to use the aerial at a later time for rescue or water tower operation. Proper set-up can save valuable time in an ever changing emergency situation.

### WARNING

### On Tiller Models, set TRAILER BRAKE (control in apparatus cab). Brake must be applied prior to operating aerial.

- 1. With engine at slow idle (600 rpm approx.), shift transmission to N (neutral) and set parking brake.
- 2. Follow the instructions provided by the water pump manufacturer for procedures regarding pump set up.

### CAUTION

#### Once the pump is engaged, the pump must receive water from a source within a few minutes to avoid damage to seals. Make sure proper connections and setup are complete before engaging water pump.

- 3. Engage fire pump in accordance with ELECTRIC PUMP SHIFT instructions on control placard (located in the cab dash area). (See Figure 36.)
  - NOTE: Typically with the transmission in neutral, the pump shift switch can be actuated. A green PUMP NOT IN GEAR light will be activated at the switch panel. The transmission must then be shifted into D (drive). Two green OK TO PUMP lights will be activated, one at the switch panel, and one at the pump panel area.

### If pump shift is not properly completed, power is directed to the rear axle and the vehicle can move forward suddenly and unexpectedly.



If engine stalls with fire pump engaged, disengage pump before attempting to restart engine.

- 4. Follow the instructions provided by the water pump manufacturer for procedures regarding control of the pump.
- 5. With the pump engaged the aerial can be activated at any time. The PTO must be engaged without moving the transmission selector. The aerial power switch must activated and the front steering axle wheels must be chocked (both front and rear). While the pump is engaged, idle speed is limited to the setting for pump operation and the aerial fast idle system is inoperative.

### PREOP REQUIREMENTS AERIAL & WATER TOWER APPLICATIONS

NOTE: Units with or without a water pump can be used as a Water Tower. Units without a pump will require another unit with a pump to supply water to the rear/side inlet of the aerial unit. Water can then be pumped through the unit's waterway to the monitor. Units with a water pump will need to engage it for water tower operation.

Position apparatus in the best poss ible location, keeping in mind that operating "over the 1. rear" on rear mounted units offers optimum reach with minimal obstruction by truck equipment.

- 2. With engine at slow idle (600 rpm approx.), shift transmission to N (neutral) and set parking brake.
- 3. Follow procedure as outlined under AERIAL APPLICATION ONLY for engagement of PTO.
- 4. Chock front steering axle (in front and behind tires).
- 5. Actuate fast idle, located at the both the R.H. and L.H. outrigger control station, and follow procedure as outlined in the OUTRIGGER OPERATION Section.
- 6. With the outriggers properly set, the aerial can be moved to the proper position for water tower use. Refer to AERIAL OPERATION Section for correct procedure.



•Before engaging water pump, make sure that the proper procedures have been •Before engaging water pump, make sure and followed as identified in the manual provided by pump manufacturer.

•Do not attempt to engage water pump while the fast idle is activated.

7. With the engine at slow idle (600 rpm approx.), engage the fire pump in accordance with ELECTRIC PUMP SHIFT instructions on the control placard (located in the cab dash area). (See Figure 36.)

NOTE: Typically with the transmission in neutral, the pump shift switch can be actuated. A green PUMP NOT IN GEAR light will be activated at the switch panel. The transmission must then be shifted into D (drive). Two green OK TO PUMP lights will be activated, one at the switch panel and one at the pump panel area.

### **DANGER** If pump shift is not properly completed, power is directed to the rear axle and the vehicle can move forward suddenly and unexpectedly.

- NOTE: Illumination of the "OK TO PUMP" indicators signify that the apparatus drive wheels have been disconnected.
- NOTE: Some units utilize air to engage the pump. Basic system operation is the same but instead of an electric switch in the cab, a lever performs the On/Off function. Follow the instructions provided on the Pump Shift placard.
- 8. The water pump can now be used to send water through the aerial waterway and supply the monitor and nozzle. Refer to the pump manufacturers' manual for correct procedures.
- 9. Your unit may be equipped with a manual or electric monitor. Manual monitors feature controls mounted directly on them. A hand-wheel is provided for each of the monitor's directional functions. The nozzle uses a rotation or slide control for adjustment of the stream. (Refer to Manual Monitor Operation Section for more information.)
- 10. An electrically controlled monitor will usually have controls at the turntable and on the sliding monitor mount. Controls for each monitor/nozzle function are provided. (Refer to Electric Monitor Operation Section for more information.)
- 11. Electric monitors are functional as long as the PTO Switch, located on the cab dash, is in the "ON" position or if PTO on visual display system is on.

END

### SECTION 7 <u>OUTRIGGER OPERATION</u> (See Figure 37, Figure 39 and Figure 40)

### **DEPLOYING THE OUTRIGGERS – REAR AND MID MOUNT UNITS**

The proper method for deployment of the outrigger system is to relieve the weight from the vehicle's springs and tires (rear tires not contacting ground, front tires contacting ground), allowing the frame and aerial torque box assembly to assume the operating load.

### **WARNING** When operating on slopes or slippery terrain, keep one set of braking tires (wheels with air-actuated, spring-applied brakes) firmly on the ground.

- NOTE: References made to left, right, front, and rear when referring to the aerial are those directions viewed when standing at the heel pin looking toward the ladder tip (ladder cradled).
- 1. Actuate applicable outrigger beam control(s) to OUT position and fully extend beam(s); repeat for remaining outrigger(s) as necessary.
- 2. Place auxiliary outrigger pads in position on ground under jack cylinders.
  - NOTE: In the event that an outrigger beam cannot be fully extended, the vertical jack can be lowered. This is a short set condition.
  - NOTE: Outrigger beams can be extended simultaneously and jacks can be lowered together to save time during set-up.
- 3. Actuate applicable outrigger jack control(s) to DOWN position and lower jack(s) until weight is removed from chassis springs; repeat for remaining side as necessary. OUTRIGGER FULLY DEPLOYED indicator light(s) should illuminate when jacks make positive contact with the ground (supporting surface).
- 4. If additional leveling is needed, deploy the outrigger beam leveling cylinder to achieve a more level position.



An electrocution hazard could exist, and death or serious injury could result from contact with any outrigger, should the apparatus become electrically charged (the outriggers being an extension of the apparatus frame).



•A moving outrigger can cause serious crushing injury Do not operate any outrigger unless you or a spotter can see that all personnel are clear of the outrigger's beam and jack travel path, and contact point.

•Outriggers must be set on solid footing. Setting outriggers on uneven or unsure surfaces could cause apparatus to tip over.





Figure 37 Apparatus Leveling Indicator

LEVELING THE APPARATUS (See Figure 39,



### If angle of <u>turntable</u> is out of levreduce aerial capacities througl

NOTE: With conditions as stated in step 3, no weight reductions are required through 360 degrees of aerial rotation.

If grade permits, level apparatus as follows:

1. Using applicable outrigger controls, raise low side of unit slightly above horizontal; lower opposite jack to level unit.

WARNING

Maintain front tire contact with ground in all sloping and level conditions.

- 2. If raising low side above horizontal cannot be accomplished due to grade, fully extend jack on that (low) side.
- 3. Lower opposite jack to adjust unit as near level as grade will allow, ensuring that outriggers are "loaded" with as much chassis weight as possible, and turntable angle is less than 6 percent (3.5 degrees) from horizontal.



Figure 38 Outriggers Deployed - Rear Mount and Tiller Models

### LEVELING THE APPARATUS.

- 5. (Mid Mount, Front Outrigger Units.) Make sure area below outriggers is clear. Lower front outriggers using single lever provided at control box. Outriggers are properly set when outrigger "Fully Deployed" light is activated.
- 6. If necessary, the outrigger beam leveling cylinders can be then be utilized to provide additional leveling capability.
- 7. Return engine rpm to slow idle (disengage fast idle).

### STOWING THE OUTRIGGERS

NOTE: Outrigger hydraulic system is not activated unless aerial is retracted, lowered, and stowed (cradled).

P т - LEFT BLANK FOR FUTURE PHOTO INSERTION -

Figure 39 Forward Outriggers Deployed - Mid-Mount



#### Figure 40 Outrigger Controls - Rear and Mid Mount

1. Actuate applicable outrigger jack control(s) to UP position and raise vertical jack(s) fully. OUTRIGGER DEPLOYED indicator light(s) should go out; repeat for remaining outrigger(s) as necessary. Front outriggers should be stowed first when applicable.

NOTE: Outrigger jacks can be raised simultaneously and beams can he retracted together to expedite withdrawal from fire scene.

- 2. Actuate applicable outrigger beam control(s) to IN position and stow outrigger(s); repeat for remaining outrigger(s) as necessary.
- 3. Retrieve and stow auxiliary outrigger pads.

### **DEPLOYING THE OUTRIGGERS – TILLER UNITS**

The proper method for deployment of the outrigger system on these tiller models is to relieve the weight from the tractor's rear axle (tractor's front tires and tiller steering axle tires maintaining ground contact), allowing the frame and aerial support structure to assume the operating load.



### When operating on slopes or slippery terrain, keep one set of braking tires (wheels with air-

actuated, spring-applied brakes) firmly on the ground.

- NOTE: References made to left, right, front, and rear when referring to the aerial are those directions viewed when facing the aerial console (at heel pin looking toward ladder tip).
- 1. Actuate applicable outrigger beam control(s) to OUT position and fully extend beam(s); repeat for remaining outrigger as necessary.
- Place auxiliary outrigger pads in position on ground under jack cylinders. Rev2

NOTE: Outrigger beams can be extended simultaneously and jacks can be lowered together to save time during set-up.

- 3. Actuate applicable outrigger jack control(s) to DOWN position and lower jack(s) until weight is removed from chassis springs; repeat for remaining side as necessary. JACK DOWN indicator light(s) should illuminate when jacks make positive contact with the ground (supporting surface).
- 4. Actuate outrigger beam leveling cylinder to provide additional leveling as needed.
- 5. Actuate fifth wheel lock cylinders to the DOWN position until the green indicator light is illuminated.



An electrocution hazard could exist, and death or serious injury could result from contact with any outrigger, should the apparatus become electrically charged (the outrigger being an extension of the apparatus frame).



A moving outrigger can cause serious crushing injury. Do not operate any outrigger unless you or a spotter can see that all personnel are clear of the outrigger's beam and jack travel path and contact point.



Outriggers must be set on solid footing. Setting outriggers on uneven or unsure surfaces could cause apparatus to tip over.



Figure 41 Outrigger Controls - Tiller Models

5<sup>TH</sup> WHEEL LOCK OVERRIDE


All auxiliary outrigger pads must be properly installed/used when outriggers are deployed.

**LEVELING THE APPARATUS** (See Figure 39, Figure 40 and Figure 42)



If angle of <u>turntable</u> is between 6 and 14 percent 3.5 and 8.0 degrees, reduce capacities through 360 degree rotation by one- half (50 percent).

If grade permits, level apparatus as follows:

- 1. Using applicable outrigger controls, raise low side of unit slightly above horizontal; lower opposite jack to level unit. Utilize the outrigger jack cylinders first.
- 2. If raising low side above horizontal cannot be accomplished due to grade, fully extend jack on that (low) side and utilize the outrigger beam leveling cylinder to level further.



**NING** Tractor front (steering) axle tires and tiller tires must remain in contact with the ground. If unit cannot be leveled without raising these tires, do not level and operate within reduced capacities.

3. Lower opposite jack to adjust unit as near level as grade will allow, ensuring that outriggers are "loaded" with as much chassis weight as possible, and turntable angle is less then 6 percent 3.5 degrees from horizontal. Actuate outrigger beam leveling cylinder to provide additional leveling as needed

NOTE: With conditions as stated in step 3, no weight reductions are required through 360 degrees of aerial rotation.

4. Return engine rpm to slow idle.

**OUTRIGGER INTERLOCK.** (See Figure 40, Figure 41 and Figure 42)

The outrigger system is equipped with an interlock feature which interfaces with the aerial controls to prevent the use of the aerial if the outriggers have not been correctly or only partially set up. This system is designed to protect the users from the possibility of tipping the truck over because of improperly positioned outriggers.

A properly set outrigger is indicated by a green light at its corresponding control station. Illumination of the light confirms that the outrigger has been fully extended horizontally and vertically, and that the unit's weight has shifted to the outrigger. If any of these conditions are not met, the light will not activate. For tiller units, the fifth wheel lock cylinders must be deployed and the corresponding green light must be illuminated.

With all green lights illuminated, electrical power is available for use of the aerial. After the ladder has been taken out of the cradle, any movement of the outriggers will not effect aerial operations.

#### INTERLOCK OVERRIDE/EMERGENCY OPERATION. (See Figures 43, 44 and 45)

The Outrigger Interlock Override system is designed to allow use of the aerial in situations where lives are at risk and no other options are available. The system allows the outrigger, on the side opposite of where the aerial is to be used, to be "short-set," or not fully extended in the horizontal direction. Deploying the outrigger without full horizontal extension of one beam is a short set condition.

Each aerial control station contains a green OUTRIGGER DEPLOYED indicator, if the green light does not come on this system warns that an outrigger has not been fully deployed and that use of the Override Switch will be necessary for any aerial functions.

# **WARNING** Use of the aerial while in an override situation MUST be limited to the area parallel with the truck forward, to parallel with the truck rearward, and on the side opposite of the 'not fully deployed" outrigger. (See Figure 45.)

When used properly the system is limits motion to the side with the outriggers deployed, but additional caution is needed because there is no system to prevent accidental or deliberate misuse by personnel.

NOTE: The ROTATION LIMITING SYSTEM will not allow you to rotate the ladder past parallel with the unit on the "short-set" side of the truck. (See Rotation Limiting System in General Information Section for more information).



Figure 42 Aerial Usage - "Short-Set" Condition



Utilization of the OUTRIGGER INTERLOCK OVERRIDE must be used as a last resort, when all other options have been exhausted. Operators must be properly trained and aware of the potential danger if procedures are not followed properly while the system is in override condition. The following steps identify correct use of the system:

- 1. When arriving at the scene, placement of the apparatus must be carefully considered to avoid the need for repositioning the truck.
- 2. Follow the directions under DEPLOYING THE OUTRIGGERS to attempt a set-up. When it is determined that an outrigger cannot be extended fully, or lowered fully, it will be necessary to move the object(s) that block full deployment.

If the objects cannot be moved, consider repositioning the truck.

NOTE: Experience and knowledge of the unit's capabilities and limitations should eliminate the need to "short-set" outriggers. This allows the Interlock Override System to be used in "EXTREME EMERGENCY" situations for which it was designed.

- 5. When the determination has been made that an outrigger must be "short-set," extend the outrigger (opposite the side which the aerial will be used) to the farthest point possible.
- 6. Extend the opposite outrigger's Beam Cylinder fully.
- 7. Place the Outrigger Shoring Pads under the Jack Cylinder engagement area for each outrigger.
- 8. Extend the Jack Cylinders until the weight is relieved from the suspension, while using the Apparatus Level Indicator for proper leveling of the unit. (See Figure 37)
- 9. Refer to AERIAL OPERATION (INTERLOCK OVERRIDE MODE) for procedures while using aerial in the above described condition.

#### OUTRIGGER INTERLOCK OVERRIDE - MANUAL CONTROLS, REAR AND MID MOUNT UNITS. (See Figure 43)

In the event of an electrical failure, the Interlock Override Switch will become inoperative and it will be necessary to use the Manual Circuit Selector and the Manual Interlock Override button to lower the Jack Cylinder in the "short-set" condition. The procedure is as follows:

1. Interlock Override Switch and Outrigger Function controls are identified as inoperative.



#### Figure 43 Outrigger Override/Emergency Controls - Tractor Drawn, Rear Mount & Mid Mount Aerials

- 2. Two people will be required to perform this override operation.
- 3. Pull momentary Manual Interlock Override and hold while moving Outrigger Control Handle to lower Jack Cylinder (Auxiliary O/R pads are in place).
  - NOTE: In normal or emergency operation, the possibility of a hydraulic failure is always present. In this situation it is necessary to use the E.P.U. (Emergency Power Unit) Switch to supply hydraulic power in conjunction with the systems previously described. (See E.P.U. Operation Section.)
- 5. Repeat steps (1) through (3) as necessary.

#### **OVERRIDE/EMERGENCY OPERATION - TRACTOR DRAWN** (See Figure 43)

A manually operated, EMERGENCY OVERRIDE system control and manually- operated outrigger function controls are located at the main outrigger control station, on the left side of the apparatus. Prior to actuating the applicable controls on the outrigger valve bank, the OUTRIGGERS manual override knob must be pulled and held in the actuated position, for the duration of outrigger operation.

This action manually shifts the blocking solenoid valve, shutting off oil to the aerial system and directing flow to the outrigger valve bank. Controls for override of the individual outrigger functions are located on the applicable sections of the outrigger valve bank.

END

#### SECTION 8 AERIAL OPERATION

#### GENERAL SAFETY INSTRUCTIONS

### WARNING

•An untrained operator subjects himself and others to death or serious injury. Do not attempt to operate the apparatus until you read, understand, and can apply the safety precautions and operating procedures contained in all applicable manuals and regulations.

•Before attempting any aerial operation, review SAFETY PRECAUTIONS, and CAPACITIES AND LIMITATIONS Sections of this manual.

•Do not operate this unit until you have been fully trained in its safe and proper operation by qualified personnel.

•You must operate within the limits of your employer's work rules and all applicable government regulations.

•Failure to obey any of the following could result in death or serious injury.

- 1. Inspect vehicles and aerial DAILY, including functional check of all systems.
- 2. Outriggers must be set on solid footing to prevent tip over.
- 3. Operators shall wear a body belt and use a lanyard to secure to ladder.
- 4. Always operate all controls slowly for smooth motion.
- 5. Do not load aerial beyond rated capacity. (Refer to Aerial Load Chart at operator's station).
- 6. Operator should wear proper protective gear.
- 7. Read and comply with all safety and operating decals on apparatus.

As a safety precaution, the operator should make note of and report any signs of trouble observed during normal operation. Be alert for any of the following:

- 1. Excessive hydraulic pressure.
- 2. Hydraulic oil leaks.
- 3. Excessive hydraulic oil consumption.
- 4. Any unusual noise or vibration.
- 5. Any erratic movement of ladder or controls.

WARNING

A qualified operator must remain at the turntable control station at all times.

#### **AERIAL FUNCTIONS** (See Figure 48)



NOTE: Maximum aerial strength is afforded at the shortest radius, with the ladder at maximum length and highest permissible elevation.

NOTE: The recommended sequence of aerial operation is elevate, rotate, and extend. The reverse sequence holds true for stowing the ladder.

The Aerial Power Foot Switch must be actuated throughout all aerial functions.



If a tipping condition is encountered, retract the aerial to return to allowable operating envelope. Never lower or extend ladder, as this will only lition

worsen the condition.





Before raising the ladder, ensure that area above ladder is clear of all obstructions. All handle movements should be smooth.

Position ELEVATION control lever to Raise position; hold until ladder reaches desired elevation and smoothly return to the neutral position.

NOTE: Engine rpm and the control lever distance from neutral determine speed of raising ladder.

#### Lowering the Ladder



## Before lowering ladder, ensure that area below ladder is clear of all obstructions and personnel.

Position ELEVATION control lever to DOWN; hold until ladder reaches desired elevation and smoothly return control to the neutral position.

NOTE: Engine rpm and the control lever distance from neutral determine speed of lowering ladder.

### WARNING

Do not rest ladder on any structure. The ladder is designed to support rated loads in the unsupported configuration.

**ROTATING THE AERIAL** (See Figure 45)

Before swinging aerial in either direction, ensure that rotation path is clear of obstructions and personnel.

Never rapidly reverse rotation direction as a sudden change of direction could dislodge personnel on the ladder, turntable, platform, and/or damage the rotation mechanism.

### CAUTION

Ensure that aerial is raised sufficiently to clear cradle, cabinetry, accessories, etc., prior to rotating. At low elevation angles with the ladder extended the ground speeds at the ladder tip during rotation can approach 20MPH.

Position ROTATE control lever to LEFT or RIGHT as required; hold until aerial reaches desire position and smoothly return control to the neutral position.

- NOTE: To increase rotation speed, control handle is moved further away from Neutral (center position). To decrease rotation speed, control handle is moved closer to Neutral (center position).
- NOTE: Better "feathering" control of rotation movement (when close to operating hazards, i.e., buildings, power lines, etc.) can be attained with engine at "slow idle" rpm.
- NOTE: Aerial is equipped with an automatic rotation brake. Brake will engage when control handle is returned to Neutral (center position).

#### **EXTENDING/RETRACTING THE LADDER** (See Figure 45)

NOTE: Refer to markings on ladder for readout of LADDER EXTENSION (length).

#### Extending the Ladder



Never extend ladder with personnel onboard, as sufficient power exists to mangle or sever any limb caught between rungs.



•Before extending ladder, ensure that extension path is clear of obstructions and personnel.

•Do not rest ladder on any structure. The ladder is designed to support rated loads in the unsupported configuration.

Position TELESCOPE control lever to OUT; hold until ladder extends to desired length and smoothly return control to the neutral position.

NOTE: Engine rpm and control lever distance from neutral determine speed of ladder extension.

#### **Retracting the Ladder**



Never retract ladder with personnel onboard, as sufficient power exists to mangle or sever any limb caught between rungs.



Do not rest ladder on any structure. The ladder is designed to support rated loads in the unsupported configuration.

Position TELESCOPE control lever to IN; hold until ladder retracts to desired length and smoothly return control to the neutral position.

NOTE: Engine rpm and control lever distance from neutral determine speed of ladder retraction.

MONITOR AND NOZZLE OPERATION, ELECTRIC - TYPICAL (See Figure 45)



Refer to Aerial Load Chart for maximum horizontal and vertical :: sweep of nozzle.



Do not hold nozzle against any stop or full travel position in any function, as damage to motor may occur.

NOTE: Controls for nozzle operation are located on the Aerial Control Console and at the ladder tip.

When monitor retractable mount is pinned to outer-mid section, the nozzle should be remotely controlled from aerial console. Sweep nozzle to reposition stream whenever possible (as opposed to rotating aerial). Refer to vendor information, supplied with monitor and nozzle, for additional information.

#### **Raising and Lowering the Nozzle**

Position RAISE/LOWER control to direction required; hold until nozzle reaches desired position.

#### Adjusting Nozzle Pattern

Position STREAM/SHAPE control to pattern required; hold until desired pattern is formed.

#### Sweeping the Nozzle

Position RIGHT/LEFT control to direction required; hold until nozzle reaches desired position.

#### **BUTTERFLY VALVE - OPTIONAL**

(Use with Aerial Fly Section preconnects.)

The butterfly valve mounted just behind the monitor is used to divert water to the preconnects for handline use. Complete shut-off of water should not be attempted from the tip unless; (1) pump operator has been notified first; (2) flow has been shut off to the aerial waterway; (3) an emergency situation exists which does not allow redirection of waterflow.

NOTE: Most situations will allow the ladder tip operator to redirect flow and contact required personnel for a proper shutdown.

Butterfly valve(s) are moved to the closed position for preconnect use. System relief valve(s) will activate if pressure exceeds desired limits.

#### LADDER TIP PRECONNECTS - OPTIONAL.

The preconnects located in the fly section waterway are designed to allow hand lines to be used from the tip position. Connection to non-gated valves must be done before charging waterway. Gated preconnects can be connected from the ground or any structure accessible to the ladder. Valves should be in the closed position and caps must be removed before any connections are made. Butterfly valve should be moved to the closed position to divert water to the preconnects.

NOTE: When the aerial has been committed to preconnect use, both rescue and water tower capabilities are greatly limited.



#### PINNING RETRACTABLE MONITOR FOR OPERATION. (See Figure 46)

# WARNING Waterway must be fully drained, ladder fully retracted, and aerial positioned to zero degrees elevation, before changing pinned position of monitor.

- NOTE: Since rescue capability remains the primary concern when arriving at a fire scene, it is recommended that the monitor be pinned to the outer-mid section as standard configuration. For maximum water tower operations, the monitor is pinned to the fly section.
- 1. Drain waterway as necessary, and retract and position aerial at zero degrees elevation.
- 2. Engage locking handle in the appropriate position for selected monitor configuration (aerial water tower, or rescue); refer to placards adjacent to sliding mount for latching locations.

## **AERIAL OPERATION OUTRIGGER INTERLOCK OVERRIDE MODE.** (See Figures 47 and 50)

With an outrigger in a "short-set" condition, the Outrigger Not Deployed lights at the turntable control console will be illuminated. In order to actuate the aerial functions, you first engage the dead man foot switch and then hold the rotation interlock Override Switch in the on position continuously while operating the control levers. This maintained style of switch is designed to make each aerial function deliberate and thought out while in the override mode. The interlock Override Switch can be released when aerial movement is complete.



Figure 45 Rotation Interlock Override Emergency Controls – Aerial



Movement of the aerial/turntable to positions past parallel to truck or on the same side as a "short-set" outrigger will cause unit to tip over. *Do not under any conditions move aerial to the prohibited positions*.



**Releasing the Interlock Override switch while in motion will cause the aerial to stop abruptly.** 

#### Rotation Limiting System. (See Figures 47 and 48.)

The Rotation Limiting System is designed to assist the aerial operator by not allowing him to move the aerial into a restricted position due to a "short-set" outrigger. This system does not excuse the operator from making sure the aerial is not moved into the prohibited area identified by the warning decals, and pertinent information in this manual. Any indication that the system is not functioning correctly should be reported immediately. Operation must then be done assuming that the system is down and the operator is totally responsible for limiting the aerial's movement manually.

Proper function of the system is as follows:

- 1. If the truck is "short-set," the appropriate Outrigger Not Deployed light will be illuminated in red at the turntable control console. To operate the ladder, the interlock override switch must be held continuously while operating ladder controls.
- 2. In order to allow for cradling of the ladder, there are approximately 2 degrees of rotational travel past the vehicle centerline. This small angle will not allow the ladder to tip over the other side and will assist with bedding the ladder.



Figure 46 Rotation Status

- 3. With the ladder in the cradle, the ladder is near the rotational limit. Rotation toward the "short-set" side will be cut-out after approximately 2 degrees of rotation.
- 4. When the rotation limit is reached, no further rotation is allowed in this direction.

- 5. Rotation away from the "short-set" side is possible. The ladder can rotate in that direction.
- 6. If you continue to rotate 180 degrees toward the "short-set" side, the ladder rotation will stop and rotation will only be allowed away from the "short-set" side.



# Movement of the aerial/turntable to positions beyond identified limits toward a "short-set" outrigger will cause unit to tip over. *Do not under any conditions move aerial to prohibited positions*.

#### Manual Override/Emergency Procedure. (See Figures 47 and 48)

Crimson aerials ladders utilize manual hydraulic aerial controls to actuate ladder movements. In the case of an electrical failure, the control levers for aerial operation act directly on the aerial main control valve and remain functional. In the event of an electrical failure, two people will be required to operate the aerial device. One person must pull and hold the aerial override solenoid knob located in the drivers side outrigger area.

NOTE: Blocking solenoid at the outrigger control station must be in the inactive or IN position for normal aerial use (normal position).

A second person can now use the aerial controls following the normal procedures identified in the non- emergency section. Because there has been a failure within a major system, the rotation interlock may not be functional. In order to avoid tipping the truck over the rotation interlock valves must be manually operated to rotate the aerial. These valves are located on the front side of the turntable control console and are labeled for direction. The appropriate override knob must be held and the aerial rotate function operated. Since a major electrical malfunction has occurred, it is important that only essential functions be completed, and the electrical problem corrected as quickly as possible.

When all procedures are complete, it will be necessary to return the blocking solenoid in the outrigger area to the normally closed position by releasing the knob returning it to the neutral position.

In the event that a hydraulic failure has also occurred, it will be necessary to utilize the EPU (see Emergency Power Unit Operation Section) to supply hydraulic fluid to the valve bank.

#### **Charging/Draining Aerial Waterway – Typical**

- NOTE: Prior to charging waterway, maneuver aerial into best position to direct nozzle stream.
  - 1. Charge aerial waterway as follows:



### Prior to charging waterway, insure that nozzle(s) are positioned in a safe and effective direction.

a. Check that a rear discharge valve and waterway drain valve are closed and capped as applicable.

b. Complete procedure to engage fire pump as necessary.

c. Slowly open applicable water supply valve(s) at pump panel to charge system; adjust relief(s) as necessary.

d. Actuate butterfly valve as necessary to discharge water from monitor.

CAUTION

Drain waterway immediately in freezing conditions. Failure to do could result in damage to seals of telescoping sections.

- 2. Drain aerial waterway as follows:
- a. Close applicable water supply valve(s) at pump panel.

CAUTION

Do not attempt to drain waterway by retracting aerial.

b. Slowly open manual aerial drain valve and drain waterway. Stay away from discharge point to keep dry.

NOTE: Waterway will drain easier with ladder elevated.

#### FLOW METER

The aerial waterway flow meter, which can be mounted at turntable or pump gauge locations, is used to identify water flow in gallons per minute (gpm). Meter allows flow limits, listed on Unit Load Chart, to be identified easily. An optional Total Gallon Usage feature supplies readings for fire fighting and environmental purposes.

#### **OPERATING IN SUBFREEZING CONDITIONS**

•Before operating in freezing and subfreezing environments, ensure that all control cables, linkages, cylinders, handholds, walking surfaces, etc. are free of all snow and ice deposits.

•Visually inspect rotation gear and pinion for any snow or ice accumulations that would restrict operation.

NOTE: If snow or ice is hampering any aerial function, "jog" applicable control to help free actuator (cylinder, cable, linkage, etc.).

When operating in extremely cold, subzero temperatures, the hydraulic pump should be operated at "slow idle" until the hydraulic oil reaches a minimum of 60 degrees F (15.6 degrees C). This helps prevent the pressure filter from bypassing cold, thick oil directly into the system, without the benefit of filtration. Warmer oil also reduces the stiffening effect that cold temperature causes on flexible hoses.

Special attention must be paid to the hydraulic oil in ensuring that it is kept free of water contamination. Emulsified water can freeze out of the hydraulic oil as crystals, in turn blocking the suction line filter and causing pump cavitation and possible hydraulic pump damage).

#### STOWING THE AERIAL.



Observe all DANGER, WARNING, and CAUTION notices applicable to the individual operations required for stowing aerial.

1. Drain aerial waterway as necessary. (See Charging/Draining Aerial Waterway ) If monitor is equipped with an Automatic Stowing Feature, engage the auto-stow switch and wait until monitor returns to the full in-line position. Visually determine that the monitor is properly stowed.



(Tiller Models.) Ladder must be fully retracted before lowering into cradle. Failure to do so could result in serious injury or death to tillerman and/or

damage to tiller cab.



•When returning ladder to cradle, ensure that sufficient elevation is maintained to clear apparatus cab and attachments.

•Ensure that ladder is aligned with cradle when stowing ladder so that cabinets, lights, etc., are not damaged. (See Figure 12, Turntable Alignment Indicator.)

2. Fully retract, rotate, and lower aerial into cradle; hold ELEVATION control in DOWN position and gently "power" aerial into cradle. This will aid in preventing aerial "bounce" during travel.



If monitor is not aligned properly, damage to monitor and cab roof/tiller deck can occur.

- 3. Raise and stow outriggers; retrieve and stow auxiliary outrigger pads.
- 4. Adjust engine speed to "slow idle" and disengage PTO (power take off).
- 5. If so equipped, actuate LADDER POWER Switch (in apparatus cab) to OFF position.
- 6. Shift apparatus transmission to Neutral (N) if fire pump was in use during aerial operation.
- 7. Actuate ELECTRIC PUMP SHIFT Switch to ROAD (UP) position.
- 8. Retrieve and stow wheel chocks.

**AUTOMATIC MONITOR STOW (optional)** If the aerial is equipped with an automatic monitor stow feature, the monitor will automatically be returned to the stowed position.

The system functions as follows:

- 1. Ladder should be positioned over the cradle.
- 2. The ladder elevation angle is brought below 10 degrees.
- 3. The ladder lowering motion is automatically stopped
- 4. The control system automatically sends a signal to the monitor's auto-stow circuit to bring the monitor to the stowed position
- 5. The operator should verify that the monitor is properly stowed.
- 6. To return the ladder to the cradle, the turntable operator must deploy the Aerial Stow Enable momentary switch on the control console
- 7. The ladder can then be lowered into the cradle.

END

#### **SECTION 9 EMERGENCY POWER UNIT (EPU) OPERATION**

#### **EPU OPERATION (12 volt)** (See Figures 43, 44 and 48)

The Emergency Power Unit consists of a 12 volt electric motor and a small hydraulic pump which, when activated, allows the operator to move the aerial or outriggers in the event of a main system failure. The system is capable of all functions in a no-load condition. However, because of the short continuous use time limit (approximately three minutes, depending on the circuit being activated), it is important that only required functions be used to move personnel and equipment to safety. Functions should be limited to those associated with wrap-up of the aerial (i.e., lowering, rotating and retracting). The outriggers can also be folded-up (stowed), to allow truck movement in a situation of impending danger.

The EPU can be used over a long period of time at a low duty cycle, which is approximately 30 seconds in every 3 minutes.

NOTE: The EPU should be run every 10 hours of aerial use to circulate oil in the system and ensure the unit is working properly.



•Actual operating time is dependent on batteries' state of charge and hydraulic pressure in circuit(s) being moved.

•The EPU is rated for a maximum of three minutes (approx.) continuous operation. Exceeding this period of time could cause the unit to fail.

NOTE: EPU operation is independent of aerial electrical system other than batteries.

- 1. Disengage main hydraulic pump PTO.
- 2. Actuate EPU Switch to ON position and hold for duration of emergency system operation. Switches are located at each outrigger control station and the turntable operator's position.
- 3. Operate applicable controls and stow aerial and/or outriggers as necessary.
- 4. Release EPU Switch.

#### **EPU OPERATION 110 Volt Systems** (See Figures 43, 44 and 48)

The 110 VAC Emergency Power Unit (110 VAC EPU) consists 3.5 horsepower electric motor coupled to a small case hydraulic pump which, when activated, allows the operator to move the aerial or outriggers in the event of a main system failure. This system is capable of continuous operation of ladder and outrigger functions with no time restrictions. The maximum pump flow rates for this system provide operation at 10-15% of maximum function speed dependent on the specific function selected.

1. The main hydraulic pump PTO should remain engaged.

2. Engage aerial emergency power circuit breaker in main AC breaker box. This makes power available to the solenoid that controls the 110VAC EPU. Rev1

3. Engage and hold momentary EPU control switch (engaging 110VAC solenoid) at the applicable control location and simultaneously engage the normal control levers for the aerial or outrigger function desired. Utilize the momentary override in combination with the control function, to reduce the build up of pressure and heat when the aerial is not operating.

4. Release EPU Switch and switch off the breaker at the main breaker box to 110 VAC EPU.

END

#### **SECTION 10 LUBRICATION**

#### TYPES OF LUBRICANTS.

Even though specific brands are recommended in Table L-1 and on the Lubrication Chart, substitutions may be necessary due to regional availability, operating conditions, environmental temperatures, and the continual development of improved products. When substitution is necessary, or when questions arise, contact your nearest authorized **Crimson Fire** Dealer/Distributor/Service Center, or call the factory Customer Service Department.

EP(MPG) Extreme Pressure Multipurpose Grease. A synthetic multipurpose, moly-compound grease. This high load carrying capacity grease has the following properties:

Extreme Pressure Properties (Timken Load) ASTM D-2509 45 lbs. (20.4 kg.) Dropping Point ASTM D-566 500 degrees F(260 degrees C) Viscosity Index 140 mm. Water Resistance Excellent

NOTE :This synthetic EP lubricant is specifically recommended for use on the aerial waterway. Consult Crimson Fire Service prior to using any alternate grease.

EPGL Extreme Pressure Gear Lubricant. This gear lubricant is compounded to achieve high load carrying capacity and meet the requirements of either API-GL-5 or MIL-L-2105C. Unless otherwise specified, SAE EP9O viscosity may be used for year-round service. Low temperature use is restricted as follows:

SAE Viscosity No.	Mm. Ambient Temp.					
75W	-40 degrees F (40 C)					
80W	-15 degrees F (-26 C)					
85W	+10 degrees F (-12 C)					
90	+20 degrees F (-7 C)					
140	+40 degrees F (+5 C)					
250	+50 degrees F (+10 C)					

HYDOHydraulic Oil.The oil in a hydraulic system provides three primary needs: the<br/>medium for transmission of power, system/component lubrication, and system<br/>cooling. Selecting an oil with all of the essential properties is paramount in ensuring<br/>optimum system performance. (Refer to Hydraulic Oil Recommendations, this<br/>Section.)

#### HYDRAULIC OIL RECOMMENTATIONS

When it becomes necessary to replenish or replace the oil in the reservoir, any of the oils listed in Table L-1 are suitable substitutes for operating in the -15 degrees F to 210 degrees F (-26 degrees C to 99 degrees C) temperature range.

#### **TYPES OF LUBRICATION POINTS**

NOTE: Check all oil levels with apparatus parked on level surface in road ready position, and while hydraulic oil is cold.

On plug-type check points, oil level should be at bottom edge of port opening, unless otherwise specified.

All grease fittings are SAE standard. Lube non-sealed fittings until grease begins to seep from fitting.



Worn grease fittings that will not hold the gun, and fittings with a stuck check ball, must be replaced.

NOTE: 28 Grams (1 oz.) of EP multipurpose grease is expelled with one pump of a standard 0.45 kg. (one pound) grease gun.

Brush-on lube points require coating the surface uniformly with a thin film of grease.

For areas equipped with wear pads, be sure to cycle the component(s) several times to ensure complete lubrication.

Oil Mfgr.	Туре	VIS @ 37.8C (100F)	<b>VIS @</b> 98.9C (210F)	<b>ISO</b> Grade	cS (Metric)
Arco	Duro AW 32	155	44	32	5.5
Chevron	AW Hyd. Oil 32	150	44	32	5.5
Citgo	All Temp	150	46.6	32	6.9
Conoco	Super Hyd. Oil 32	165	47	32	7.03
Exxon	Nuto H 32	155	43.7	32	5.4
Getty	Aturbrio #AW #51	150	43	32	5.1
Gulf	Harmony 32 #AW	150.2	43.3	32	5.2
Kendall	Kenoil R+O AW 32	174	50.4	32	7.4
Mobil	Mobil DTE #24	150	43.6	32	5.39
Pennzoil	AW #32 Hyd. Oil	160	43	32	5.1
Phillips	Mangus A Oil 32	170	45	32	5.9
Shell	Tellus 32	150	44.8	32	5.8
Sun	Sunvis 706	155	43.8	32	5.4
Standard	Energol HLP 32	153	43	32	5.1
Texaco	Rando Oil HD 32	154	43.8	32	5.4
Union	UNAX AW 32	150	43.6	32	5.39

Figure 47 Hydraulic oil and Ratings

When lubricating sealed U-joints, use extreme care to prevent rupturing the seals. Apply lubricant only until expansion of seals first becomes visible.

Unless specified elsewhere, items not equipped with grease fittings, e.g., linkages, levers, pins, etc. should be lubricated once a week. Those items exposed to water, foam, etc., more frequently (in service) should be wiped clean and lubricated as required. SAE 30W motor oil is adequate for this application.

#### 1. LUBRICATION CHART - GENERAL. (See

, Figure 49 and Figure 50)

The lubrication chart in this section reflects typical component installations on standard model units. Lube points and locations on subassemblies could vary slightly as changes in manufacturer and/or design may result in relocation and/or number of lube fittings, fill plugs, drain plugs, etc.

Should any conflict of information arise between lubricant recommendations on the lubrication chart for vendor components and those appearing in applicable vendor's publication, contact the nearest vendor representative for clarification.

Using the lubrication chart Check/Lube column as a guideline, it is important that items be lubricated on a regular basis. The items listed may not need additional lubrication, and adding additional grease or oil may cause a problem by trapping dirt particles. It is therefore important that the condition of each item be determined. Check your unit at the required intervals and lubricate if the following conditions are evident:

- 1. Dry spots on normally greased surfaces.
- 2. Bare metal or painted areas showing where grease has been rubbed off.
- 3. Oil levels are low in any component.

When checking areas that have grease fittings it will be necessary to connect a grease gun and attempt to pump grease into the component. If grease is required a crackling sound will be heard as air is forced out of the grease cavity. Continue pumping until grease is forced out of the mating part seams or gun becomes noticeably hard to pump. Wipe off any excess grease to avoid a dirt and grim collection point.

#### NOTES:

- 2. Be sure to lubricate like items on opposite sides of aerial.
- 3. Frequency of lubrication is recommended by the manufacturer for apparatus use under normal conditions. Where severe operating conditions exist, the user must adjust the lubrication schedule accordingly.
- 4. Refer to TYPES OF LUBRICATION POINTS, this Section for detailed specifications.
- 5. Before substituting any lubricant, contact your nearest authorized Crimson Fire Dealer/Distributor/Service Center, or call the factory Consumer Service Department.

			1
	Comments	Slowly rotate turntable while lubing bearing (min 1 rev. ea 3 Pumps 3 Pumps 3 Pumps 3 Pumps 3 Pumps	
	METHOD	Hand Gun Hand Gun Hand Gun Replace Element Liquid Fill Hand Gun Liquid Fill	
	CHECK/LIUBE	Every 20 Hrs Every 20 Hrs Every 20 Hrs Every 20 Hrs Every 20 Hrs Daily Every 20 Hrs Every 20 Hrs Every 20 Hrs	
(te Side)	ТҮРЕ	Hydro EP EP E	
5 (Opposi	QTΥ	1 ea	
	DESCRIPTION	Aerial Ladder Rotation Bearing Lift Cylinder Spherical Bearings Waterway Heel Pin Swivel Return Line Hydraulic Filter Pressure Line Hydraulic Filter Hydraulic Oil Reservoir Aerial Telescopic Waterway Water Monitor Horizontal & Vertical Pivot Points Swing Drive Planetary Gear Box	52 Lubrication Chart, Rear Mount Aerials
	ITEM	- N M 4 90 P 80 6	Figure

6. All oil levels are to be checked with ladder retracted and cradled, apparatus parked on a level surface, and while oil is cold.

Figure 48 Lubrication Chart, Rear Mount

Figure 49 Lubrication Chart, Tractor Drawn.

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#### Figure 50 Lubrication Chart, Mid Mount.

#### LUBRICATION CHART - GENERAL. (CONT'D)

- 6. All grease fittings are SAE Std. Apply lubricant until grease extrudes from fitting; wipe fitting clean of excess grease.
- 7. Unless otherwise specified, items not equipped with grease fittings (linkages, control cables, pins, levers, etc.) should be lubricated with oil (SAE 30) once a week. Apply oil sparingly. A light application of oil will provide the necessary lubrication and aid in preventing rust formation.
- 8. Fittings that are worn and will not hold a grease gun, or those that have a stuck check ball, must be replaced.

#### LUBRICATING WIRE ROPE.

Wire rope (ladder ext./ret. cables) is lubricated during its manufacturing process. Hot lubricant is applied to each wire and each strand as strands are twisted to form the rope. This lubrication cannot remain for the life of the rope. Therefore, additional lubricant must be applied periodically to maintain the rope in serviceable condition.

Wire rope is a machine. Keeping it lubricated is as vital as putting oil in your car's engine. The lubricant serves two purposes; it reduces surface wear, and it protects the rope. When wire rope is in use, the internal surfaces rub against each other, and the outside wires wear against the sheaves. Properly applied lubricant will not only protect the outside surface, but will also penetrate to the inner strands and reduce internal wear.

Lubricating wire rope in the field presents special problems, and the frequency of application depends on the nature of operation and types of environments. Periodic inspection is the best approach to maintaining wire rope in optimum condition.

END

#### SECTION 11 SERVICE AND MAINTENANCE

#### GENERAL.

The Service and Maintenance Section provides basic instruction for maintenance personnel to perform needed service measures for best aerial operation throughout the life of the unit. Only personnel that have been "factory" trained at Crimson Fire, or by their personnel, should be permitted to service the unit.



Damage to aerial systems and/or personnel is possible if unit maintenance is performed by personnel that have not been factory trained.

#### DRAINING AND FLUSHING AERIAL HYDRAULIC SYSTEM.



If a component has been changed because of a failure that might allow metal or abrasive particles to enter the system, all systems must be thoroughly checked, drained, and flushed.

- 1. Open reservoir drain valve. Allow approximately three minutes, after oil stops flowing from drain port, for side walls to drain.
- 2. Close drain valve and fill reservoir with clean hydraulic oil.
- 3. Cycle apparatus through all functions several times; then return ladder to stowed position; shut down engine.
- 4. Open reservoir drain valve drain reservoir. Close drain valve and fill reservoir with clean oil.



Oil supply lines must be connected to the cylinders when flushing the system.

- NOTE: Draining the various components will be facilitated by connecting a drain line in place of the disconnected return line.
- 5. Disconnect return lines from lift cylinders and raise ladder to maximum elevation. (See Figure 55)

WARNING

Do not loosen crossover line while aerial is in an elevated position.

- NOTE: The crossover line is protected by (2) two velocity fuses, plumbed at each end of the line. If the line would become damaged, the fuses shut when the hydraulic flow exceeds 1 gpm.
- 6. Connect cylinder return lines and lower ladder to stowed position. Replenish reservoir oil level as required.



Figure 51 Lift Cylinder Connections.

- 8. Connect the outrigger return line and retract outrigger. Replenish reservoir oil level as necessary.
- 9. Repeat steps 7 and 8 for remaining outriggers.

# **CAUTION** When draining jack cylinders, always operate opposing cylinders together to prevent excessive twisting of the chassis.

- 10. Disconnect return lines from the outrigger jack cylinders and extend cylinders to maximum down position.
- 11. Connect return lines and raise jack cylinders to stowed position. Replenish oil level as necessary.
- 12. With ladder at zero degrees elevation, disconnect the extension/retraction cables and move the cables clear of the cylinders.
- 13. Disconnect return line from both telescope cylinders and fully extend cylinders.
- 14. Connect return line and retract cylinders.
- 15. Shut down hydraulic system.
- 16. Open drain valve and drain all oil from hydraulic reservoir.

# **WARNING** If aerial has been operating, allow sufficient time for hydraulic oil to cool down before draining reservoir. Hydraulic oil in the reservoir can reach temperatures capable of causing severe burns if skin contact occurs.

- 17. Remove access plate from top of reservoir and wipe inside walls with clean, lint-free cloth and suitable solvent.
- 18. Clean magnetic drain plug.
- 19. Fill reservoir with new filtered-clean hydraulic oil.
- 20. Cycle all aerial and outrigger functions several times and recheck oil sight/level gauge. Replenish oil as necessary.
- 21. Draw oil sample from reservoir for analysis.



## When oils are changed or added, ensure that oils of different manufacturers are of the same specifications. If not, discoloration (milkiness) may occur.

NOTE: When hydraulic oils are changed, recheck reservoir oil level after brief system operation and add oil as required.

Reservoir capacity is 40 U.S. Gallons (151 liters). Ensure apparatus is in travel position and standing level when system is being filled. The system must be filled with all cylinders retracted and ladder bedded. Fill the reservoir to full mark on the reservoir sight/level gauge. After reservoir is filled, operate all functions and recheck reservoir level. Add oil as required.

#### **BLEEDING AIR FROM AERIAL HYDRAULIC SYSTEM**

Due to the manner in which the hydraulic system is designed, air entering the hydraulic oil will normally be removed automatically by passage of the oil over the baffles in the hydraulic reservoir. However, if a component has been replaced, the reservoir level has been too low, or a leak develops in the suction line to the pump, air can enter the system. If air becomes entrapped in the hydraulic oil, it may be detectable in pump and motor-operated components, such as the swing drive (these units become noisy during operation). Should noisy operation occur, first check oil level in the hydraulic reservoir and replenish as necessary. Then inspect for leaks in the suction line leading to the pump.

### CAUTION

Never check for hydraulic oil leaks with your hands. Hydraulic oil under pressure, combined with a pin hole leak, can lacerate skin like a razor. Also, never stick your head in a confined area "looking for leaks."

Minute leaks may be difficult to locate. Should you encounter a leak that is not readily detectable, the following method may be used. Seal all normal openings in the hydraulic system and the reservoir. Using a positive means to control the pressure (i.e. a regulator), pressurize the hydraulic system to 13.79 to 27.6 kPa/O.1379 to 0.276 bar (2 to 4 psi) and inspect all joints and fittings for evidence of leaks. A soap solution applied to the fittings and joints may also prove helpful in detecting minute leaks while the system is pressurized. Shut off pressure, repair leaks, and open any openings (vents, etc.) closed for inspection. Refill the reservoir after completing repairs or service. Operate all hydraulic circuits several times in both directions. This action should return any entrapped air to the reservoir where it can be removed from the oil by the integral baffle system.

NOTE: Follow all procedures outlined in Outrigger Operation and Aerial Operation Sections for set-up and use of the aerial unit.



Extreme care must be used when removing any plugs or restrictions from a hydraulic system suspected to have entrapped air that may be pressurized.



•Position apparatus on a firm supporting surface and position aerial in most stable position when extending ladder at low angles.

•Before running aerial, position apparatus on a firm supporting surface. Set up aerial in most stable position when extending ladder at low angles.

•Do not exceed Load Chart limitations.

Entrapped air may be removed from cylinders having wet rods by cycling. On certain cylinders, a plugged port is provided on the rod end to bleed off entrapped air.

WARNING

Do not attempt to loosen fittings in pressurized lines or while the hydraulic pump is in operation.

In the event that air entrapment should persist, bleeding of air by loosening various clamp and screw-type fittings may become necessary.

#### **CONTROL VALVES**

The valve banks controlling ladder functions are installed on the turntable assembly. Outrigger control valves are installed at the rear of the apparatus.

**Inspection.** Inspect control valves for visible damage, binding spools, and evidence of leakage. If excessive internal leakage is suspected during operation with spool in center (neutral) position, it is possible that the area between the spool and working bore section of the valve body is worn beyond serviceable limits. If this condition exists, the spool and body must be replaced as an assembly.

**Main Relief Valve Checks.** The main relief valves, incorporated in the control valve assemblies, are pilot operated. The compression of the pilot spring within the relief valve body controls the relief opening of the pilot poppet valve. When the pilot poppet valve opens, hydraulic oil enters under pressure and opens the large poppet in the valve, thereby protecting the system components from pressures over and above their design ratings.

### CAUTION

## Adjustment of main relief valves should be made only by qualified personnel using the proper equipment.

#### Valve Leakage Checks.

Class I leakage is defined as seepage of fluid causing wetness or discoloration, but no drops. This needs to be monitored.

Class II leakage is defined as leakage enough to form drops, but not enough to cause drops to fall. This needs to be monitored.

Class III leakage is defined as leakage great enough to cause drops to fall. This is a severe external leaks and is bad enough to take the apparatus out of service for immediate repairs.

External leaks sometimes develop at fittings and seals. Spool seals are leak susceptible since they are subject to wear. Seals may be damaged by temperatures that are too high, dirt, or paint accumulation on the spool. Damaged seals must be replaced.

Warped mounting surfaces can distort the assembly and cause leakage and extrusion. To check for valve distortion, loosen the mounting bolts slightly. If the leakage stops when the bolts have been backed off slightly, distortion was the problem. This valve section will need to be removed and replaced.

Good oil is always a good investment. The money saved by switching from the recommended grade to a cheaper grade will probably be money spent repairing or replacing prematurely worn components, or cleaning sludge out of the system. Hydraulic oil should be filtered before it is added to the reservoir. New oil is not highly filtered from the manufacturer.

A component functioning at reduced speed or efficiency may indicate that the control valve for the component is leaking internally. Assuming preliminary check-out reveals adequate volume is being supplied to the affected valve bank, relief valves are properly adjusted and the component is not at fault, the next step would be to check the valve for scored or worn parts.

Scoring is a sign of the NUMBER ONE PROBLEM in hydraulics— CONTAMINATION: external contamination by dust, or internal contamination by debris from deteriorating components or oxidized oil. Scored or severely worn valve components must be replaced.

Also check the valve for rust. Rust or dirt collecting on the linkages can prevent free movement of the spool, and keep it out of true center position.

Excessive pressure spikes can create both internal and external leaks in valves that are otherwise sound. Therefore, it is extremely important that relief valves be adjusted only by qualified personnel using the proper equipment.

**Causes of Sticking Valve Spools.** Some of the most common causes for stiff valve spool movement or jammed spool action are: system overheating, excessive pressure, contaminated or deteriorated oil, or warped mountings. When deteriorated oil or contamination is the cause, flushing the system and replenishing with clean oil may solve the problem. If the spool bores are badly scored or galled, the valve must be removed for servicing. If the oil is scorched or deteriorated, similar action is required.

Warpage also occurs when mounting plates are not level, or become distorted from apparatus damage. As mentioned previously, the valve should be replaced if the sections are warped or distorted.

Oil breakdown will occur if the oil becomes contaminated with air, water, or dirt, or if the oil is exposed to excessively high temperatures or pressures. Even with normal usage, the additives that inhibit rust, oxidation, and foaming lose their effectiveness. Follow the recommended oil change intervals and procedures. They are intended to get the oil out of the system before it starts breaking down and before deterioration harms the system.

Check Valves. Most control valve assemblies have an integral load-holding check valve. If this check valve is not functioning properly, the load will drop before moving upward or drift when stationary.

Check valves are designed to permit a flow of oil in one direction only. If a piece of dirt or rust has worked its way into the check valve, and lodges between the poppet and the seat, it will keep the valve open just enough to allow a return flow of oil and actuator movement.

#### MAIN RELIEF VALVES

The main relief valves, incorporated in the control valve assemblies, are pilot-operated. Turning the adjustment screw changes the compression of the pilot spring within the relief valve body, which in turn controls the relief opening of the pilot poppet valve. When the pilot sections poppet valve opens, hydraulic oil enters under pressure and opens the large poppet in the valve, thereby protecting the system components from pressures over and above their design ratings.

UNIT OF MEASURE	MAXIMUM	SWI	NG	TELESCOPE		ELEVATION		OUTRIGGER					
	MEASURE	SYSTEM PRESSURE	RIGHT	LEFT	EXT	RET	RAISE	LOWER	ЕХТ	RET	LEVELING CYL EXT	LEVELING CYL RET	JACK EXT
PSI	207	103	10	103	103	172	55	207	207	207	207	207	207
BAR	3000	1500	150	1500	1500	2500	800	3000	3000	3000	3000	3000	3000

#### Figure 52 Main and Circuit Relief Valve Settings.

#### Verification of Relief Valves Settings



All main relief valves have been properly adjusted at the factory. Do not adjust any valve unless a preliminary pressure check reveals that the pressure setting is not within 10.3bar (150 psi) of the maximum circuit operating pressures listed in Table SM-1.

- Only qualified service personnel should attempt adjustment of these valves.
- 1. Perform the following preparation steps before verifying settings.

a. Check engine operation at "fast" and "slow" idle with no load; do not exceed 1500 rpm. Adjust the idle speed as necessary.



# Warm up hydraulic oil by normal apparatus operation. Do not subject apparatus to undue strain for quicker results.

b. Activate hydraulic system and operate aerial until hydraulic oil temperature reaches a minimum of 60 degrees F (15.6 degrees C).



#### Never actuate valve spools rapidly. Always use slow, even movements.

c. Check control valve spools to assure that all spools have full travel (stroke) in either direction.

NOTE: The system pressure gauge should be used for this check.

- 2. Using fast idle control at outrigger or aerial control station, set engine speed at approximately 1500 rpm with no load applied.
- 3. Apply a load to the cylinder(s), motor, etc., in the applicable circuit being checked, sufficient to activate main relief valve.



Do not hold pump on relief for more than one minute at a time. Release control lever after taking each reading and while making necessary adjustments.

- 4. Move applicable control lever slowly to end of its travel, in the direction for which motion has been blocked. Note maximum reading on pressure gauge. The gauge will show a drop in pressure when the relief valve opens.
- 5. If pressure of relief valve does not agree within (+) 150 psi of that listed in table, relief valve needs to be reset. Consult factory for proper relief valve procedure for each function.
  - NOTE: Circuit pressures in this table are the maximum gauge pressures that should be read during operation of the corresponding functions. Lower gauge pressures should be of no concern as long as circuits/functions are operating properly.

#### CHANGING HYDRAULIC SYSTEM FILTER ELEMENTS

#### General.

It is recommended that the pressure filter be changed every 50 hours, and the return filter be changed every 100 hours of aerial operation or when by-pass filter indicator is in the red zone. This may happen more frequently in unusually contaminated atmospheres, and it may be necessary to replace the filters at a more frequent rate.

NOTE: Oil filter bypass/condition indicators are only useable with the system running, and when oil temperature is above 100 degrees F.

#### Pressure Line Filter.

### WARNING

Do not attempt to change pressure line filter with hydraulic system operating.

1. With hydraulic system shut down, loosen and remove filter housing from porting head by turning nut on housing base; drain residual oil in housing into suitable container.



When removing filter element, check for metal particles. If particles are found, this is an indication of possible component failure. Determine/repair malfunction and drain, flush, and refill system with clean hydraulic oil before installing new filter element.

If no evidence of contamination or component failure is found, but element is excessively dirty, drain, flush, and refill system before installing new filter element.

- 2. Remove and discard housing seal and filter element.
- 3. Clean inside of housing with soft-bristle brush and 50-50 mixture of clean hydraulic oil and kerosene (diesel fuel); wipe housing dry with lint-free cloth.



#### **Ensure that housing seal is properly positioned in housing groove.**

- 4. Install new seal and insert new element in housing.
- 5. Position housing assembly, engaging threads of porting head; carefully tighten housing by turning nut on housing base.

#### Return Line Filter. (See Figure 53)



# Do not attempt to change return line filter with hydraulic system operating.



When removing filter element, check for metal particles. If particles are found, this is an indication of possible component failure. Determine/repair malfunction and drain, flush and refill system with clean hydraulic oil before installing new filter element.



If no evidence of contamination or component failure is found, but element is excessively dirty; drain, flush, and refill system before installing new filter element.

- 1. With hydraulic system shut down, loosen and remove cap screws and washers securing cap to filter assembly porting head; remove cap.
- 2. Lift out bypass spring assembly and remove filter element from case.
- 3. Clean inside of case with soft-bristle brush and 50-50 mixture of clean hydraulic oil and kerosene (diesel fuel); wipe case dry with lint-free cloth.
- 4. Install new element in case and position bypass spring assembly on top of element.
- 5. Place filter assembly cap on porting head; secure with washers and cap screws.

#### TROUBLESHOOTING

#### **Quick-Check List — Pre-op Problems.**

The following information represents some of the more common, probable pre-op problems that could be encountered during deployment of the apparatus. This is not a comprehensive list meant to examine every possible malfunction of the equipment, but rather a "quick-check" list to aid operating personnel in determining if a mere oversight is the cause of preventing proper deployment of the unit.

- 1. PTO will not engage.
  - a.Reference Set-Up Procedure Section 6-1 for proper engagement steps for the particular transmission and PTO combination on your unit.
  - b. Check: Transmission should be in neutral and parking bakes set
- 2. Outrigger circuit will not activate.
  - a. Check: PTO not engaged (see item 1).
  - b. Check: Cradle limit switch out of adjustment or defective.
  - c. Check: Hydraulic supply line (tank) valve closed. Open valve.
- 3. Aerial controls inoperative (Electrical power O.K.).
  - a. Check: PTO not engaged (see item 1).
  - b. Check: Outriggers not properly deployed.
  - c. Check: Malfunction in outrigger/aerial interlock system.

<u>Systems and Circuits – General</u> Before attempting to troubleshoot any failed system or circuit, there are several key points to emphasize. Maintenance personnel must know the operating characteristics and limitations of the unit and be familiar with the locations and functions of all components and controls.

The troubleshooting charts in this section have been developed as a guide to help in isolating the most probable cause(s) for system and/or circuit malfunction. In most cases the troubleshooting procedure reflects a symptom caused by a single component failure.

Prior to troubleshooting any problem, it is advisable to gather all available support information, i.e., apparatus maintenance file, hydraulic and electrical schematics, vendor data, etc., as the charts alone do not provide detailed procedures for all required maintenance.
TROUBLE	PROBABLE CAUSE	REMEDY
Pump noise due to cavitation.	1. Hydraulic oil level low.	1. Fill reservoir to FULL mark on sight/level gauge. DO NOT OVERFILL.
	2. Improper oil viscosity.	2. Drain and refill system. (Refer to Draining and Flushing Aerial Hydraul- ic System, this section.)
	3. Clogged hydraulic line or fitting.	3. Clean or replace line or fitting.
	4. Loose or broken supply line.	4. Tighten or replace line.
	5. Supply line shutoff valve closed.	5. Open shutoff valve.
Foaming hydraulic oil.	1. Hydraulic oil level low.	1. Fill reservoir to FULL mark on sight/level gauge. DO NOT OVERFILL.
	2. Loose or broken supply line.	2. Tighten or replace line.
	3. Incorrect type of oil in system.	<ol> <li>Drain and refill system. (Refer to Draining and Flushing Aerial Hydraul- ic System, this section.)</li> </ol>
Cloudy hydraulic oil	1. Excessive moisture in system.	1. Drain, flush, and refill system. (Refer to Draining and Flushing Aerial Hydraulic System, this section.)
Overheating hydraulic oil.	1. Hydraulic oil level low.	1. Fill reservoir to FULL mark on sight/level gauge. DO NOT OVERFILL.

### HYDRAULIC PUMP AND RESERVOIR TROUBLESHOOTING

TROUBLE	PROBABLE CAUSE	REMEDY
Overheating hydraulic oil.	2. Improper oil viscosity.	2. Drain and refill system. (Refer to Draining and Flushing Aerial Hydraul- ic System, this section.)
	3. Contaminated hydraulic oil.	<ol> <li>Determine/correct cause of contamination; drain, flush, and refill system. (Refer to Draining and Flushing Aerial Hydraul- ic System, this section.)</li> </ol>
	4. Clogged or damaged relief valve.	4. Clean or replace valve.
Main pump shaft seal leaks.	1. Scored or chipped shaft.	1. Determine/correct cause. Replace all seals.
	2. Defective seal or gasket.	2. Replace seal or gasket.
Pump not delivering fluid.	1. Coupling or shaft sheared or disengaged.	1. Check that pump drive is properly engaged, If driveshaft or coupling is damaged or sheared, remove and repair, or replace as necessary.
	2. Reservoir-to-pump supply line restricted or broken.	2. Clean, repair, or replace line as necessary.
	3. Air entering at suction manifold.	<ol> <li>Check all lines for secur- ity, manifold for cracks and proper attachment.</li> </ol>
	4. Pump not priming.	4. Tighten, repair, or replace components as necessary,

### HYDRAULIC PUMP AND RESERVOIR TROUBLESHOOTING (CONT'D)

TROUBLE	PROBABLE CAUSE	REMEDY
Pump not delivering fluid.	5. Internal contamination.	5. Repair or replace pump. Drain, flush, and refill system. (Refer to Draining and Flushing Aerial Hydraulic System, this section.)
	6. Load sense hydraulic pressure block.	6. Check for pressure in small line to hydraulic pump and for blockage.
	7. Shuttle valve malfunction.	7. Check if aerial controls work. Replace shuttle valve.
Excessive pressure build-up.	1. System relief valve set too high.	<ol> <li>Use adequate pressure gauge and adjust system relief valve as necessary. (Refer to Main Relief Valve Adjustment, this section.)</li> </ol>
	2. Restricted pump-to- control valve supply line.	<ol> <li>Clean, repair, or replace as necessary.</li> </ol>
Pump noise (accompanied by oil foaming in reservoir).	1. Air entering at suction manifold.	1. Check all lines for security, manifold for cracks and proper attachment. Tighten, repair, or replace components as necessary. Check oil level in reservoir. (Fill to FULL mark on sight/level gauge. DO NOT OVERFILL.)

### HYDRAULIC PUMP AND RESERVOIR TROUBLESHOOTING (CONT'D)

### OUTRIGGER SYSTEM TROUBLESHOOTING

TROUBLE	PROBABLE CAUSE	REMEDY
Slow or erratic operation of outrigger extension cylinder.	1. Defective main relief valve.	1. Remove relief valve: clean or replace.
	2. Hydraulic oil level low.	2. Fill reservoir to proper level. Fill to FULL mark on sight/level gauge. DO NOT OVERFILL.)
	3. Scored valve spool.	3. Remove and replace spool.
	4. Relief valve defective.	4. Repair or replace relief valve.
	5. Defective extension cylinder (internal parts).	5. Remove extension cylinder and repair as necessary.
	6. Bent piston rod.	6. Replace piston rod and seals.
	7. Foreign material on beam(s) causing binding.	7. Clean beam(s) as necessary.
	8. Malfunctioning selector valve or two-way solenoid.	8. Repair or replace defect- ive component(s).
	9. Main hydraulic pump cavitation.	9. Replace or retighten hose and fittings.
	10. Worn or defective main hydraulic pump.	10. Repair or replace pump.
	11. Insufficient voltage to solenoid.	11. Check/repair wiring/ connectors/swivel contacts.
	12.Load sense pressure not reaching pump.	12.Check for pressure in load sense line (small hose) at pump. Check to see if shuttle valve is shifting freely.

TROUBLE	PROBABLE CAUSE	REMEDY
Outrigger extends while apparatus.	1. Leaking piston seals.	1. Replace seals as roading necessary.
	2. Air in extension cylinder.	2. Bleed air as necessary. (Refer to Bleeding Air From Aerial Hydraulic System, this section.)
	3. Scored cylinder barrel.	3. Hone barrel or replace cylinder.
	4. Cracked or damaged piston.	4. Replace piston and seals.
	5. Piston loose on rod.	5. Replace seal and tighten retainer nut to proper torque.
Outrigger vertical stabilizer cylinder slow or erratic.	1. Hydraulic oil level low.	1. Fill reservoir to FULL mark on sight/level gauge. DO NOT OVERFILL.
	2. Defective main relief valve.	2. Remove relief valve; clean or replace as necessary.
	3. Leaking pilot check seals.	3. Replace pilot check valve. CAUTION: Use extreme care in rein- stallation to avoid damaging new seals.
	4. Bent piston rod.	4. Replace piston rod and seals.
	5. Binding outrigger housing.	5. Realign, repair, or replace outrigger housing.
	6. Foreign material on beam(s) causing binding.	6. Clean beam(s) as necessary.

TROUBLE	PROBABLE CAUSE	REMEDY
Outrigger vertical stabilizer cylinder	7. Main hydraulic pump cavitating.	7. Tighten or replace hose(s) and/or fitting(s).
siow of effault.	8. Worn or defective main hydraulic pump.	8. Repair or replace pump as necessary.
	9. Load sense pressure not reaching pump.	9. Check for pressure in load sense line and proper shuttle valve operation.
Vertical outrigger	1. Leaking piston seals.	1. Replace piston seal.
under load.	2. Leaking pilot check valve.	2. Replace pilot check valve.
	3. Scored cylinder barrel.	3. Hone barrel or replace cylinder.
	4. Cracked or damaged piston.	4. Replace piston and seal.
	5. Piston loose on rod.	5. Replace seal and retorque piston hardware.
Vertical outrigger	1. Leaking piston seals.	1. Replace seals.
roading apparatus.	2. Scored cylinder barrel.	2. Hone barrel or replace cylinder.
	3. Cracked or damaged piston.	3. Replace piston and seals.
	4. Piston loose on rod.	4. Replace seal and re- torque piston hardware.
	5. Leaking pilot check valve.	5. Replace pilot check valve.
	6. Defective holding valve.	6. Replace valve assembly.

TROUBLE	PROBABLE CAUSE	REMEDY
Sticking valve spool.	1. Excessively high oil temperature.	1. Eliminate any restric- tion in hydraulic line(s) or filtering system.
	2. Dirt in oil. Dirt trapped in valve assembly.	2. Drain, flush, and refill system. (Refer to Drain- ing and Flushing Aerial Hydraulic System, this section.)
	3. Pipe fittings too tight.	3. Check torque. Tighten fittings to proper value.
	4. Valve warped from improper torquing of tie bolts.	4. Loosen tie bolts and retorque to proper value.
	5. Excessively high pressure in valve (relief valves not working properly.	5. Check pressure at inlet and at working ports. (Refer to Table SM-1 for correct pressure settings.)
	6. Spacer bent.	6. Replace valve.
	7. Return spring damaged.	7. Replace faulty parts.
	8. Spring or valve cap binding.	8. Loosen cap, recenter, and retighten.
Leaking valve seals.	1. Paint on or under seal.	1. Remove and clean, as necessary.
	2. Excessive back pressure.	2. Open line to reservoir.
	3. Dirt under seal.	3. Remove and clean as necessary.
	4. Scored spool.	4. Replace valve.
	5. Loose seal plates.	5. Clean and tighten plates.
	6. Cut or scored seal.	6. Replace defective parts.
	l l	

TROUBLE	PROBABLE CAUSE	REMEDY
Unable to move valve spool in or out.	1. Dirt in valve.	1. Clean and flush valve assembly.
	2. Spool cap full of oil.	2. Replace seals.
Poor hydraulic perform- ance, or failure.	1. Damaged pump.	1. Check pressure or re- place pump.
	2. Dirt in relief valve.	2. Disassemble and clean relief valve.
	3. Relief valve damaged.	3. Replace relief valve.
	4. Worn cylinder(s) or motor(s).	4. Repair or replace dam- aged components as necessary.
	5. Internal valve crack.	5. Replace valve.
	6. Spool not at full stroke.	<ol> <li>Check movement; repair/ replace components as necessary.</li> </ol>
	7. Hydraulic oil level low.	<ol> <li>Fill reservoir to FULL mark on sight/level gauge. DO NOT OVERFILL.</li> </ol>
	8. Pressure line filter clogged.	8. Clean or replace filter element as necessary.
	9. Hydraulic line(s) restricted.	9. Check lines. Clean and/or repair as necessary.

TROUBLE	PROBABLE CAUSE	REMEDY
All aerial functions operate erratically.	1. Hydraulic oil level low.	1. Fill reservoir to FULL mark on sight/level gauge. DO NOT OVERFILL.
	2. Engine rpm too low.	2. Increase engine rpm to "fast idle" setting.
	3. Loose hose and/or fit- ting allowing air to enter system.	3. Tighten or replace fit- tings/hose as necessary.
	4. Partially closed valve in oil intake manifold.	4. Open valve and lock in open position.
	5. Worn or defective hydraulic pump.	5. Repair or replace as necessary.
All aerial functions operate slow.	1. Engine rpm too slow.	1. Increase engine rpm to "fast idle" setting.
	2. Restriction in return line.	2. Clear restriction or replace return line.
	3. Aerial in need of lubrication.	3. Lubricate aerial as necessary. (Refer to Lubrication Chart, Figures 51, 52, and 53.)
Controller not functioning.	1. Master Power Switch in "Off" position.	1. Pull "On" in both locations.
	2. PTO not engaged.	2. Turn PTO Switch to "On " position.
	3. Vehicle in "short-set" condition (red or "not deployed" light should be illuminated).	3. Use Interlock Override Switch in conjunction with controller.
All aerial functions inoperative.	1. Hydraulic oil level low.	1. Fill reservoir to FULL mark on sight/level gauge. DO NOT OVERFILL.
		I

### **AERIAL SYSTEMS - GENERAL TROUBLESHOOTING**

#### All aerial functions 2. Broken pump 2. Replace pump. driveshaft. inoperative. 3. Worn hydraulic pump. 3. Repair or replace pump. 4. PTO not engaging 4. Check transmission shift properly. lever position. 5. Three-way valve 5. Repair or replace threeway valve. defective. 6. Seal(s) in hydraulic 6. Replace seal(s) as swivel leaking. necessary. 7. Blocking solenoid 7. Replace solenoid. defective. 8. Master electric power 8. Position switch "ON", or switch in cab in "off" repair/replace as position or defective. necessary. 9. Cradle limit switch out 9. Repair or replace of adjustment or switch. defective. 10. Aerial/outrigger inter-10. Replace relay. lock relay defective. 11. Restriction in line or 11. Replace line or fitting. fitting. 12. System relief not set 12. Reset as necessary. properly. (Refer to Table SM-1 for correct pressure setting.)

PROBABLE CAUSE

REMEDY

### AERIAL SYSTEMS - GENERAL TROUBLESHOOTING (CONT'D)

TROUBLE

13.Load sense signal not reaching pump. 13.Check for pressure in

operation.

the load sense line and proper shuttle valve

TROUBLE	PROBABLE CAUSE	REMEDY
Aerial raises and extends erratically.	1. Hydraulic oil level low.	1. Fill reservoir to FULL mark on sight/level gauge. DO NOT OVERFILL.
	2. Engine rpm too low.	2. Increase engine rpm to "fast idle" setting.
	3. Circuit and/or relief valve inoperative.	3. Replace defective valve.
	4. Aerial in need of lubrication.	4. Lubricate aerial as necessary. (Refer to Lubrication Chart.)
	5. Extension or retraction cables, or both, not properly adjusted (too loose).	5. Adjust (tighten) cables as necessary. (Refer to Ext./Ret.Cable Adjust- ments, this section.)
	6. Aerial flow controls blocked.	6. Set aerial flow controls to matching settings.
Aerial raises and extends slowly.	1. Hydraulic oil level low.	1. Fill reservoir to FULL mark on sight/level gauge. DO NOT OVERFILL.
	2. Engine rpm too low.	2. Increase engine rpm to "fast idle" setting.
	3. Defective system relief valve.	3. Clean, repair, or replace relief valve.
	4. Hydraulic oil extremely cold.	<ol> <li>Operate unit, allowing oil to reach operating temperature (approx. 60 degrees F).</li> </ol>
	5. Aerial in need of lubrication.	5. Lubricate aerial as necessary. (Refer to Lubrication Chart.)
	6. Improper movement of control lever to neutral.	6. "Feather" controls to neutral to maintain smooth operation.

### ELEVATION AND TELESCOPING SYSTEMS TROUBLESHOOTING

TROUBLE	PROBABLE CAUSE	REMEDY
Aerial lowers and retracts slowly.	1. Hydraulic oil level low.	1. Fill reservoir to FULL mark on sight/level gauge. DO NOT OVERFILL.
	2. Engine rpm too low.	2. Increase engine rpm to "fast idle" setting.
	3. Defective system relief valve.	3. Clean, repair, or replace relief valve.
	4. Hydraulic oil extremely cold.	<ul> <li>4. Operate unit, allowing oil to reach operating temperature of approx.</li> <li>60 degrees F (15.6 degrees C).</li> </ul>
	5. Aerial in need of lubrication.	5. Lubricate aerial, as necessary. (Refer to Lubrication Chart.)
	6. Restriction in return line.	6. Clear restriction or replace line.
	7. Cylinder piston seals worn.	7. Replace piston seals.
	8. Scored cylinder barrel.	8. Hone barrel or replace cylinder.
	9. Piston rod broken (loose from piston).	9. Replace piston rod and seals.
Aerial will not raise or extend.	1. Hydraulic oil level low.	1. Fill reservoir to FULL mark on sight/level gauge. DO NOT OVERFILL.
	2. System relief valve sticking open.	2. Readjust system relief valve. (Refer to Table SM-1 for correct pressure setting.)
	3. Engine rpm too low.	3. Increase engine rpm to "fast idle" setting.

### ELEVATION AND TELESCOPING SYSTEMS TROUBLESHOOTING (CONT'D)

TROUBLE	PROBABLE CAUSE	REMEDY
Aerial will not raise or extend.	4. Cradle limit switch out of adjustment or defective.	4. Repair or replace switch.
	5. Outriggers not properly positioned.	5. Redeploy outriggers. Check that all OUT- RIGGER DEPLOYED indicator lights are illuminated.
Ladder will not lower or retract.	1. Hydraulic oil level low.	1. Fill reservoir to FULL mark on sight/level gauge. DO NOT OVERFILL.
	2. System relief valve sticking open.	2. Adjust system relief valve. (Refer to Main Relief Valve Adjustment, this section.)

### ELEVATION AND TELESCOPING SYSTEMS TROUBLESHOOTING (CONT'D)

### **ROTATION SYSTEM TROUBLESHOOTING**

TROUBLE	PROBABLE CAUSE	REMEDY
Aerial swing function	1. Defective relief valve.	1. Replace relief valve.
direction.	2. Engine rpm too low.	2. Increase engine rpm to "fast idle" setting.
	3. Hydraulic oil level low.	3. Fill reservoir to FULL mark on sight/level gauge. DO NOT OVERFILL.
	4. Defective pinion bearing.	4. Replace pinion bearing.
	5. Improperly torqued swing motor attach bolts.	5. Replace swing motor bolts. Torque to proper value.
	6. Defective swing drive.	6. Repair/replace swing drive.
	7. Inadequately lubricated turntable bearing.	7. Lubricate bearing. (Refer to Lubrication Chart.)
	8. Apparatus not level.	8. Level apparatus. (Refer to Leveling the Apparatus, OUTRIGGER OPERA- TION Section.)
	9. Defective swing motor.	9. Replace swing motor.
	10. Aerial overload.	10. Reduce load. (Refer to Aerial Load Chart.)
	11. Swing drive oil level low.	11. Fill to proper level. (Refer to Lubrication Chart.)
	12. Improperly torqued turntable bolts.	12. Replace turntable bolts. Torque to proper value. (Refer to Aerial Swing System, this section.)
Aerial will not swing in either direction.	1. Defective swing motor.	1. Repair or replace swing motor.

TROUBLE	PROBABLE CAUSE	REMEDY					
Aerial swings slow in one direction.	5. Improperly torqued turntable bearing bolts.	5. Replace turntable bolts. (Refer to Aerial Swing System, this section.)					
	6. Not enough pressure or flow from pump.	6. Check pump for proper performance.					
Aerial swings erratically in one direction only.	1. Circuit relief valve inoperative.	1. Clean, adjust, or replace valve as necessary.					
	2. Apparatus not level.	2. Level apparatus. (Refer to Leveling the Appara- tus, OUTRIGGER OPER- TION Section.)					
	<ol> <li>Turntable bearing bind- ing, due to continuous limited duty in one direction.</li> </ol>	<ol> <li>Lubricate turntable bearing.(Refer to Lubrication Chart.) Rotate machine in both directions several times (360 degrees) after lubricating.</li> </ol>					
	4. Restricted hydraulic line or fitting.	4. Clear restriction or replace line or fitting.					

### **ROTATION SYSTEM TROUBLESHOOTING (CONT'D)**

### **AERIAL SYSTEM**

The rotation bearing and gear assembly is the most critical maintenance item on the apparatus. It is here, at the centerline of rotation, that the aerial loads are concentrated. Additionally, the bearing and gear assembly provides the only attachment between the chassis and aerial. Inadequate lubrication of the bearing, gear, and pinion, incorrect torque of the turntable bolts, and/or loose or missing turntable bolts will eventually result in fatigue wear of the bearing and possible separation of the turntable (and aerial) from the chassis. Therefore, proper care of the rotation bearing and gear assembly and scheduled maintenance of the turntable-to-bearing attached bolts is MANDATORY in order to promote safe and efficient aerial operation. It is also the key to prolonging the service life of the apparatus.

The bearing gear is secured to the chassis-mounted torque box with 36, Grade 8,  $3/4-10 \times 4$  inch bolts. The bearing gear is attached to the turntable with 36, Grade 8,  $3/4-10 \times 2-3/4$  inch bolts An equal number of 3/4 inch, hardened steel washers are installed under the bolt heads.

Each swing drive is attached to its eccentric swing drive mounting ring using 9, Grade 8,  $9/16'-12 \times 1.5$  inch bolts. The eccentric swing drive mounting ring is attached to the turntable base plate utilizing 18, Grade 8,  $9/16'-12 \times 1.5$  inch bolts. The eccentric ring is rotated to adjust the gear mesh backlash between the bearing gear and drive gear.

### Adjustments and Servicing.

## WARNING

# Failure to maintain proper tightness of turntable bolts could result in damage to apparatus and serious injury or death to personnel.

All bearing mounting bolts are accessible form he top side by removing the turntable to ladder step cover. The turntable base

Do not use any locking devices, liquid locking compounds, etc., when installing bolts, as a false torque values will be read and such devices do not prevent fatigue failure.

If it is evidenced that the apparatus has operated with loose turntable bolts, the service life of the bolts has most likely been reduced. Therefore, all bolts and washers securing the bearing gear to the torque box must be replaced.

## CAUTION

# Ladder should be in retracted and elevated fully when checking turntable bolts. This position applies minimum load to bolts.

Repeated re-torquing may cause bolts to stretch. If bolts keep working loose, replace with new bolts of same grade and size.

If a rotation bolt breaks or is found to be broken during the checks, the defective bolt, plus the next two adjacent bolts on each side (5 total) must be replaced prior to operating the apparatus.

It is recommended that the turntable bolts be inspected and checked for proper torque after the first 50 hours of apparatus operation. The bolts may loosen in service due to traveling and operating vibrations, shock loads, temperature changes, etc. Periodic inspections should be accomplished every 400 hours thereafter, to ensure that specified tightness is maintained. Tighten turntable bolts to a torque valve of 360 lb-ft. (49.8 kg-m).

### **AERIAL TELESCOPING SYSTEM.**

### **Guidelines For Adjusting Ladder Extension/Retraction Cables.**



•Unequal adjustment of cables will pull ladder sections off center during operation

•Do not over tighten cables as undue stress will be placed on system.

### WARNING

Adjust cables equally at all times.

All cables should be kept taut, however, caution should be exercised during adjustment to avoid over tightening. When adjustments are required, perform them equally and simultaneously on each side to avoid unsymmetrical loading, resulting in binding of ladder sections and jerky operation. Improper adjustments which could result in non-proportional extension/retraction should also be avoided. This condition can readily be identified when the ladder is approaching the fully retracted position, whereby each section should reach its lowest point simultaneously.

If during extension/retraction, it is observed that any section(s) tends to pull to one side, adjustment is incorrect. Carefully analyze the problem before making hasty or unfounded adjustments.

# **EXTENSION/RETRACTION CABLE TENSION CHECKS AND ADJUSTMENTS.** (See Figure 58.)

NOTE: The extension/retraction cables are the heavy, twisted cables (wire rope) that pivot around the sheave wheels of the extension/retraction cylinders that telescope the ladder sections.

### Tension Checks.

- 1. Check tension of retraction cable(s) as follows:
  - a. With outriggers properly deployed, position ladder at 0 degrees elevation and extend to limits of operation. (Refer to Aerial Load Chart.)
  - b. Attach a spring scale (minimum 0-50 lbs. [0-23 kg.]) to cable at the midpoint between the cable sheave wheel and cable anchor (on the longest span of the cable).
  - c. Pull on scale to specified pound reading for corresponding cable given in Table SM-2. This is the maximum vertical travel distance of cable permitted.
- 2. Check tension of extension cables as follows:
  - a. With outriggers properly deployed, retract ladder (3.9 inches) 10 cm, relieving tension from extension cables.
  - b. Attach a spring scale (minimum 0-50 lbs. [0-23 kg.]) to cable at the midpoint between the cable sheave wheel and cable anchor (on the longest span of the cable).



Figure 54 Ladder Mechanical Timing Guide.

### Tension Checks. (cont'd)

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c. Pull on scale to specified pound reading for corresponding cable given in Table SM-2. This is the maximum vertical travel distance of cable permitted.

d.

Adjustments. (Refer to Table SM-2.)

### Always ensure that jam nuts are secured after cable(s) has been adjusted.

CAUTION

WARNING

When tightening cable anchor nuts, always restrict cable from turning to prevent cable twisting.

Cable strength will be greatly reduced if cable 'jumps' a sheave wheel and kinks, resulting in internal damage. If cable integrity is questionable, replace damaged cable or call dealer service representative.

To adjust cable(s) to correct tension/travel reading, adjustment must be made at anchor block that is pulling the longest span of cable.

1. Loosen jam nut; adjust cable anchor nut as necessary

NOTE: Turning anchor nut clockwise will increase cable tension. Turning anchor nut counterclockwise will decrease cable tension.

- 2. After correct tension/travel reading is attained, tighten jam nut against anchor nut.
- 3. Repeat steps 1 and 2 for each cable to be adjusted.

CABLE	CABLE/FUNCTION		SION	TRAVEL		ADJUSTMENT LOCATION
		LBS	KG	INCHES	MM	
A - B	Retraction	20	9	1.00	25.4	A or B
C-D	Extension	20	9	1.00	25.4	C or D
E - F	Retraction	20	9	1.63	41.4	E or F
G-H	Extension	20	9	1.63	41.4	G or H
I-J	Retraction	20	9	2.00	50.8	I or J
K - L	Extension	20	9	2.00	50.8	K or L

Figure 55 Extension/Retraction Cable Tension/Travel Requirements.

### STRESSED FASTENER MAINTENANCE.

The purpose of this section is to emphasize the importance of the role which nut and bolt combinations play in providing the structural integrity required by aerial devices. These fasteners are not only critical for structural strength, they seriously effect performance and reliability. Variation in torque may cause distortion, binding, or fatigue failure of components.

The following material gives complete information on all aspects of stressed fastener maintenance for your aerial unit.

HEAD SIZE	BOLT THREAD DIA.	NC THREAD/INCH	NF THREAD/INCH
1-1/2"	1"	1" - 8	1" - 12
1-5/16"	7/8"	7/8" - 9	7/8" - 14
1-1/4"	3/4"	3/4" - 10	3/4" - 16
1-1/8"	3/4"	3/4" - 10	3/4" - 16
15/16"	5/8"	5/8" - 11	5/8" - 18
3/4"	1/2"	1/2" - 13	1/2" - 20

Figure 56 SM-3 Bolt Head Size Chart.

### Identification and Application. (Refer to Table SM-3.)

How to determine the size of a stressed fastener:

- 1. Diameter—Measure the head size of the bolt. Refer to Table SM-3.
  - NOTE: Different size bolts may require different torque values. Refer to the torque value chart (SM-4) for the applicable torque values.

FINE OR COARSE	GRADE	TENSILE		3/8	7/16	1/2	9/16	5/8	3/4	7/8	1	1-1/4	1-1/2							
THREAD FASTENER	DESIGNATION	MINIMUM	TORQUE FOOT/POUNDS (MIN-MA						K.)											
$\bigcirc$	S.A.E. 2 A.S.T.M.	64,000	Low Carbon	17	26	41	56	83	140	182	270	449	718							
CAP SCREW	A-307 STEEL	P.S.I.	P.S.I.	P.S.I.	Steel	19	30	45	66	93	150	202	300	500	797					
$\bigcirc$	S.A.E. 3 STEEL	100,000 P.S.I.	Medium Carbon Steel	26 30	43	59 69	93	135	214	332	491	822	1327							
CAP SCREW	ASTM A-440			27	46	65	100	140	220	338	523	747	1194							
CAP SCREW	S.A.E. 5 STEEL		Medium	-																
BB	A.S.T.M. 354BB	105,000	Steel																	
CAP SCREW	STEEL	P.S.I.	Alloy Heat	31	50	75	110	150	250	378	583	833	1323							
(Å-325)	A.S.T.M. A-325		Treated	-	-	90	-	180	305	465 525	710	1019	1771							
	ASTM		Low Alloy	30	50	71	109	147	239	377	574	1024	1522							
CAP SCREW	A- 354-BC STEEL	125,000 P.S.I.	or Med. Carb. Quenched Tempered	34	54	81	119	167	269	427	644	1053	1695							
	S.A.E. 6 STEEL	133,000 P.S.I.	133,000 P.S.I.	133.000	133.000	133.000	133.000	133.000	133.000	Med. Carbon Steel Quenched Tempered	39	59	96	140	189	310	490	735	1242	1989
	S.A.E. 7 STEEL			Med. Carbon Alloy, Quenched Tempered	40		100	450		050		005	4070	0005						
CAP SCREW			Roll Threaded	43	65	106	150	209	350	550	825	13/2	2205							
	S.A.E. 8 STEEL	150,000 P.S.I.	Alloy Quenched Tempered	42 46	75	115	145	225	330	591	893	1486	2383							
SOCKET CAP SCREW	SOCKET HEAD CAP SCREW ALSO N.A.S. AIRCRAFT STD.	160,000	High Carbon Allov	46	71	111	156	210	345	569	864	1804	2947							
	N.A.S. 144 AIRCRAFT STD. MS 20000	P.S.I.	P.S.I.	P.S.I.	Quenched Tempered	50	81	121	176	240	395	629	964	1964	3147					
	MIL. STD. N.A.S. 624		High Carbon	52	81	126	188	255	419	668	1025	2105	3355							
	NATIONAL AIRCRAFT	180,000 P.S.I.	Alloy Quenched	VE	0,			200	410	~~	1020	2100	3000							
CAP SCREW	STEEL		Tempered	56	91	136	198	270	444	708	1085	2255	3855							

Figure 57 Torque Value Chart.

2. Length—Bolts must extend into the threaded area of the bearing, tapped shaft, or plate which they secure a distance equal to the diameter of the bolt as an absolute minimum. Further penetration of the bolt into the thread area is desirable, as long as the bolt is not bottomed-out.

### Proper Torque of Most Common Sizes and Grades of Bolts. (Refer to Table SM-3.)

Identification of bolt grade is always necessary. When marked as a high strength fastener, (Grade 5, Grade 8, etc.) the mechanic must be aware these are highly stressed components and they must be torqued accordingly. Special attention is to be given to lubrication, plating and other factors which would dictate deviation from standard torque values. The Torque Value Chart (Table SM-4) is approved by Crimson Fire and used in production on original equipment installations.

- NOTE: When maximum torque values have been exceeded, the fastener must be replaced.
- NOTE: SAE standards require the manufacturer's logo or trademark to be included in the head pattern. Certain bolts may be marked in a similar manner and not meet the specifications set forth in these standards. Bolts purchased from distributors other than the original equipment manufacturer should be accompanied by certification documents to assure that the integrity of the equipment is maintained.

### Torque Wrenches and Associated Equipment. (See Figure 59.)

1. A torque wrench is a precision device used to turn a bolt to a predetermined tightness or "torque" value. The torque wrench supplied by Crimson Fire allows the desired value to be set by turning the grip until the proper setting is reached. The setting must be locked in using the "lock" ring, located just above the grip, by turning it counterclockwise.

The ratchet head must be set for direction and must be connected to a socket and extension as required for proper connection to a bolt head. Preferably, users should have experience in the use of a torque wrench, and reference the manufacturer's instructions supplied with the tool for questions concerning basic operation.

- 2. Torque Multipliers provide the operator with bolt-turning power that requires only 1/4 the force required using conventional tools. They provide safe convenient turning power when confronted with the need for high torque values within a limited amount of working or leverage space. The torque wrench must be adjusted to a value 1/4 the desired torque value when using a multiplier. Maximum input value for the supplied multiplier is 250 ft/lbs and the maximum output value is 1000 ft/lbs.
- 3. The Reaction Bar is to be attached to the multiplier to allow it to be braced against a stationary object. The desired action of the multiplier can now be utilized.

## WARNING

The stationary object must be able to withstand forces generated by the torque wrench/multiplier combination, see Chart SM-3 for values. Rotation of the bar is opposite of the socket and torque wrench.

- 4. Backlash adapters are useful when using the 4 x 1 multiplier to "take up the slack" introduced by stacking the torque wrench, multiplier and socket. The backlash adapter maintains a constant pressure against the fastener, which allows the operator to complete the turning process with only a short swing of the ratcheting torque wrench.
- 5. The Offset wrenches, sockets and extension adapters are all designed to enable users to make proper connections to the bolts in the limited space available.



Figure 58 Proper Tool Arrangement.

NOTE: Offset wrenches change the geometry between the torque wrench and the bolt. We recommend that these items be kept in a straight line whenever possible, and angles kept at minimums to achieve the most accurate torque values.

### Using the Equipment, (See Figure 58)

After setting the torque wrench to the desired value (per the torque chart) attach the backlash adapter and the  $4 \times 1$  multiplier as shown. The proper extension, or offset wrench must then be connected with the reaction bar resting against a stationary object of suitable stability. Make the connection to the bolt head and apply even force to the torque wrench. When the desired value is reached, an audible click or snap will be heard. Stop at that time.

END

### **GLOSSARY**

The following includes technical terms, definitions, and abbreviations used in this publication. This information is provided for personnel unfamiliar with the equipment, systems, and terminology.

**Adjust** - To maintain within prescribed limits, by bringing into proper or exact position, or by setting the operating characteristics to specified parameters.

**Aerial Elevation Indicator** - A component of the aerial which shows the angle of ladder elevation relative to a horizontal reference.

**Aerial Ladder Sections** - The structural members consisting of the base section, mid- section(s) (inner-mid and outer-mid on a four section ladder) and fly section of the ladder. Normally of an open "U" truss-type design.

**Align** - To adjust specified variable elements of an item to bring about optimum or desired performance.

amp/amps - ampere/amperes (electrical).

Assy. - Assembly.

Auxiliary Outrigger Pads - The portable, oversized metal plates inserted beneath outrigger pads to give greater surface bearing area on soft ground.

**bar** - A metric unit of measure for relating pressure.

**Base Rail** - The lower rail of a ladder section to which rungs and reinforcements are attached. Metal base rails are not solid, but of a hollow tubular construction to increase strength/weight ratios.

Base Section - The first or bottom section of the ladder.

Beams - The extendible, horizontal members of the outrigger assemblies

**Bearing Raceway** - The track in which the bearings are held between the upper and lower halves of the turntable rotation bearing.

Bedding - Act of lowering aerial into cradle.

Bull Gear - See Rotation (swing) Gear.

°C - degrees centigrade (Celsius).

**Cable** - A wire rope used to transmit forces from one component to another for the purpose of extending or retracting ladder sections of an aerial device.

**Calibrate** - To determine and cause corrections to be adjusted on instruments or measuring and diagnostic equipment used for precision measurement.

CG - Center of Gravity.

**Chassis** - The basic vehicle frame consisting of main frame rails, reinforcements, crossmembers, fasteners, brackets for suspension, suspension members, axles, tires and wheels, cab, and power train.

ckt. brkr. - circuit breaker.

**cm.** - centimeters.

**Collector Rings** - A means of transmitting electrical power to the turntable from the main power supply. Usually, concentric rings made of brass are contacted by brushes to make the transfer to the circuits of specific electrical functions.

**Control Valve Body** - A main hydraulic valve, usually located in the center of the turntable. When actuated, it controls elevation, extension, and rotation of the aerial.

**Ladder Cradle** - A structural component that is attached to the frame and used to support the ladder when in the stowed (bedded) position.

Creep - See Drift.

Cu. in. - cubic inches.

cyl. - cylinder.

**dc** - direct current (electrical).

**Electrical System Components** - Any electrical item used to operate and/or control any component such as solenoids, relays, cables, switches, motors, including communication systems.

**Electrolyte** - Any substance that separates into ions when dissolved in a suitable medium and forms a conductor of electricity.

Dia. - Diameter

Defect - A discontinuity in a part that interferes with the service for which it was intended.

**Double-Acting** - A cylinder in which hydraulic fluid is applied to control movement in both directions (extend and retract).

Drift - Gravity movement of cylinders, motors, etc. under load in static condition.

**Dynamic Loading** - The application of load in motion, such as a climbing firefighter or the operation of a water stream to an aerial device.

**Rated Vertical Height** - The vertical distance measured by a plumb line from the top rung of the fly section to the ground. All measurements are taken at the maximum elevation allowed by the OEM.

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**Elongation** - The stretching of a material by which any straight-line dimension increases.

**Extension Indicator** - A device on the aerial which indicates in meters/feet the length of the ladder from the heel (pivot) pin to the last rung of the fly section.

°**F** - degrees Fahrenheit.

Fly Section - The upper or top section of the ladder.

Ft. - Foot/feet.

**Fpm** - feet per minute.

FWD - Forward.

Ga. Gauge (as in measurement).

Gal./Gals. - U.S. Standard gallon.

**gpm** - gallons per minute.

Gr. - Grade (class) usually often associated with fastener or steel strength

Guy lines/wires - A rope or cable used to steady the ladder or rescue basket.

**Hd.** - Head.

**Heat-treated Bolts** - Bolts that have been exposed to a specific temperature to increase hardness and/or tensile strength.

Heel Pin - A structural pin used at the pivot point of the ladder (base section).

**High Angle Rescue** - Rescue situation in which it is necessary to use specialized equipment for climbing and/or lowering rescue personnel to reach persons which are injured or trapped in positions. These positions are usually inaccessible by normal means.

**Holding Valve** - A valve that maintains hydraulic pressure in a cylinder until it is activated to release.

**Hydraulic System Components** - Any item of a hydraulic system, e.g., pump, reservoir, tubing, hoses, and fittings used to transmit hydraulic fluid under pressure to operate and/or control any component.

**ID** - inside diameter.

**i.e.** - that is.

IN. or in. - Inches.

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**Inspect** - To determine the serviceability of an item by comparing its physical, mechanical, and/or electrical characteristics with established standards, specifications, etc., through examination.

**Install** - The act of placing, seating, or fixing into position an item, part, or module (component or assembly) in a manner to allow the proper functioning of the equipment.

Jacks - The extendible, vertical members of the outrigger assemblies.

**K-bracing** - An added brace (forming the letter K) from the base rail to the rung and back to the base rail, which is used to add lateral stability and strength to the ladder sections.

**lbs.** - pounds.

**1g.** - long.

**Load Chart** - A load indicating instruction plate, visible from the operator's station that shows the permitted loads under varying conditions of ladder elevation and extension.

Mid-Section - The middle section of the ladder.

**Modification** - Any change to the apparatus hydraulic, electrical, mechanical, or structural systems or components, which alters the original design and/or operation as assembled by the manufacturer.

Mtg. - Mounting.

N/A - Not Applicable.

Neutral (Position) - The center position of operating controls, where the controls are not engaged.

No. - Number.

**Nozzle** - A large stream nozzle mounted on an aerial device and permanently connected to the waterway.

Nozzle Reaction - see Reaction Force.

**Overhaul** - The maintenance effort necessary to restore an item to completely serviceable/operational condition as prescribed by maintenance standards of the equipment manufacturer. Overhaul is normally the highest degree of maintenance.

**Pilot-operated** - Use of a valve to apply or activate another valve. A pilot valve is usually smaller and can be internal or external. Pilot section of valve does not see full flow of the circuit, but directs the main flow of the circuit.

**OD** - outside diameter.

**OEM** - Original Equipment Manufacturer.

**Orifice** - A restricted passageway in a fluid power system, usually a small hole drilled for the purpose of regulating a flow.

**Outriggers** - The devices which are extended out and down to the ground to stabilize the aerial device. The outriggers utilize hydraulic cylinders for movement which are either manually or electrically controlled. Structural configurations may vary.

**Outrigger Pad** - The structural component of the outrigger that makes contact with the ground. It is attached to the outrigger and capable of swiveling.

**Pinion** - The "bull" or splined drive gear (driven by the swing drive assembly) that meshes with the turntable ring gear to provide turntable rotation.

**Piston Rod** - The moveable shaft of a hydraulic cylinder that is responsible for the extension, retraction, and elevation of the aerial device or its outriggers.

**Pneumatic Lines** - The lines that supply air, normally to a breathing system or for operation of pneumatic power tools from the fly section.

**Poppet** - Portion of a "poppet type" valve which is connected to the stem and allows or stops fluid flow by its movement. Fits into seal to form seal.

psi - pounds per square inch.

**PTO** (**Power Take-Off**) - A separate gearbox attached to the transmission and used as a means of utilizing a portion of the main engine power to operate a pump or other equipment.

Qts - Quarts (U.S.).

**Qty** - Quantity.

**RAASP**- Acronym for roller assisted slide pads used in Crimson aerials. The RAASP provides a combination of rollers and slide pads on a pivoting shaft to provide smooth ladder extension and retraction.

**Relief Valve** - A pressure controlling device which bypasses hydraulic fluid to the reservoir in a valve bank section or pump to prevent excessive pressure build-up.

**Repair** - The application of maintenance services (inspect, test, service, replace) or other maintenance actions (welding, riveting, resurfacing) to restore serviceability to an item by correcting specific fault, damage, malfunction, or failure.

**Repelling** - Sport and rescue technique using rope to rapidly scale or descend vertical terrain.

**Replace** - The act of substituting a like-serviceable item (part, piece, sub-assembly) for an unserviceable counterpart.

Retainers - Devices such as buckeyes, cotter pins and snap rings that are used to hold a pin in place.

**RPM** - Revolutions per minute.

**SAE Torque Value Table** - Published standards by the Society of Automotive Engineers that provide torque requirements for specific sizes of heat-treated bolts.

**Scoring** - Lines, scratches, furrows, or cuts in a cylinder piston rod, or waterway, caused by dirt inclusions or metal filings that are dragged past the wiper seal.

**Service** - Operations required periodically to keep an item in proper operating condition; to clean, preserve, drain, paint, or lubricate, replenish fluids, air supplies, etc.

**Short Set** - The condition of an outrigger which has not been fully extended horizontally to avoid an obstruction.

**Side-to-Side Backlash** - The free-movement in a turntable rotation gear beyond the allowable wear and manufacturing tolerances; exhibited when the turntable is stopped during rotation.

Slewing (swing)- Right and left sweep of the monitor or nozzle.

**Slide Block** - A block made of a variety of materials (brass, nylatron, etc.) that acts as a spacing device, wear strip, or wear pad.

**Spirit Level** - A bubble level that is affixed to a turntable or truck body used to verify the level (horizontal attitude) of the turntable prior to operation of the aerial device.

**Stability** - The ability of the apparatus to resist overturning.

Static Loading - The application of a constant load or force to an aerial device.

Std. - Standard.

Stroke - The length that a piston rod travels when it is extended from the barrel.

**Swing** - The revolving action of the turntable and aerial assembly. Rotation and swing are used synonymously in this manual.

**Rotation Bearing** - An anti-friction bearing that provides the swing capability for the turntable and aerial assembly. Also the connecting component between the turntable and torque box assembly.

**Rotation Bearing Mounting Bolts** - The bolts that fasten the rotation bearing to the turntable structure.

**Swing Drive** - The mechanism of an aerial device that transfers power to the rotation gear, creating the torque necessary to actuate movement of the turntable.

**Rotation** (Swing) Gear - The main gear of an aerial device used for rotation of the turntable, also known as a ring gear. This gear is integral with the rotation bearing of the aerial.

**Troubleshooting** - Troubleshooting information is data provided to isolate malfunctions to a line replaceable unit, power supply, or plumbing (hydraulic, air, etc.) component. This data consists of symptoms, probable causes, and remedies. Troubleshooting is based on the supposition that the observed symptom is the result of a single cause/malfunction.

Thd. - Thread.

Thk. - Thick.

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Telescopic - Extension or retraction of ladder or by the linear motion of overlapping sections.

**Test** - To verify serviceability and detect incipient failure by measuring the mechanical or electrical characteristics of an item and comparing those characteristics with prescribed standards.

**Torque Box** - A structural component placed between the turntable and the frame of an aerial device to absorb the loads and stresses of operation.

**Torque Value** - A measure of tightness or the amount of stress that is put on a fastening device (bolt, nut, etc.) to properly secure it.

**Trunnion** - The pivoting structure fastened to an elevation cylinder which allows for elevation of the aerial device.

# END