



Annual Maintenance Checklist | S-Series



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Document Number 002607
Revision 3
November 30, 2012
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SECTION 1—TOWER AND WINCH/RAISING EQUIPMENT INSPECTION STEPS

To be done prior to lowering the tower.

Tower and Winch/Raising equipment inspection

Check for excessive wear or corrosion and replace as necessary.

Tower

- Tower base, pivot bolts and foundation fasteners
- Grout under tower base (if applicable)
- Gin pole sections
- Winch-side anchor base and fasteners
- Gin pole end plate and fasteners
- Guy anchor rods
- Fasteners on guy anchors
- Tower guy rigging near ground [shackles, turnbuckles, etc.]
- Guy cable clamps and thimbles
- Tower and guy electrical grounding rods, wires, lugs and cable clamps

Winch/Raising equipment and hardware

- Pulleys
- Gin pole guy wires (Poly rope)
- Raising cable
- Gin pole flange fasteners
- Gin pole end plate fastener

Check torque of all bolts and adjust as necessary:

- Guy cable clamps at ground end of guys
- Grounding lugs and clamps
- Foundation fasteners
- Pivot nuts and bolts [loose]
- Shackle and turnbuckle pins at ground end of guys

SECTION 2—TOWER INSPECTION STEPS

To be done after lowering the tower.

Tower Inspection

- Guy cable clamps, thimbles and swaged ends at tower end of guys
- Guy shackles and other rigging at tower end of guys
- Tower sections
- Tower and gin pole flange fasteners
- Safety wire and pins on shackles and turnbuckles

Check torque of all bolts and adjust as necessary:

- Tower flange fasteners
- Guy cable clamps at tower end of guys
- Shackle pins at tower end of guys



SECTION 3—TOWER WIRING STEPS

Tower Wiring

Open access ports at top and bottom of tower and check:

- Electrical connections between tower and slip ring wires at top of tower are secure with zip ties or tie wraps
- Tower sound damping pad is in place inside tower below slip ring
- Sufficient slack in wires at tower bottom
- No excessive abrasion to wire insulation (apply tape or repair as necessary)
- Conduit is secure at lower tower cover penetration

Control panel

- Check control panel enclosure for excessive corrosion inside and out
- Enclosure door latches and lock work properly
- Enclosure door swings open and closed freely
- Back panel is secure inside enclosure
- Security of conduit at enclosure penetration
- Security of electrical ground connections on panel, enclosure and door
- Security of electrical connections from tower and grid in panel terminal blocks – tighten screws as necessary
- Connections at PLC and watchdog board
- Connections at wireless modem and antenna
- Inspect the start and run capacitors, replace if necessary
- Overall condition of panel components -look for any signs of overheating or other damage
 - Power resistor
 - SSRs
 - Mechanical contactors
 - Power supply
 - Wires and raceways
 - MOVs (on each SSR)

Anemometer

- Security of anemometer on boom
- Security of boom and mount on tower
- Condition of tape on anemometer and wire – replace as needed
- Overall external condition of anemometer
- Cups spin freely
- Check for water or excessive condensation draining out from inside anemometer
- Check for wear on the anemometer wire in the boom and at the tower entry

SECTION 4—TURBINE INSPECTION STEPS

Turbine

Overall condition of exterior

- Blades
- Nose cone
- Cover
- Tail

Remove tail

- Check torque on all tailplane fasteners
- Check for excessive corrosion on tail parts

Remove nacelle cover

- Check interior of cover for cracking or abrasion wear
- Check condition of tail bushing

Remove nose cone

- Check interior of nose cone

Torque of all critical fasteners (see Table 1 on page 4-3)

- Blade bolts
- Tail boom mount to mainframe bolts
- Inner tail boom to outer tail boom stainless steel bolt
- Tower connection bolts - sound isolation washers are in place and in good condition
- Slip ring torque arm nut (keep loose)
- Nacelle cover front disk mount bolts
- Hub front plate set screw

Brake system

- Pump off brakes and note compressor and valve operation is normal
- Note pressure in pneumatic system reaches 100 psi
- Ensure brake callipers release fully and slide freely on shoulder bolts
- Ensure rotor is free to spin
- Spin rotor one complete revolution and check for any visible brake disk wobble or warp
- Check that system pressure has held steady after 15 minutes
- Release brake system pressure and note application of brake callipers
- Ensure brakes are applied fully and hold rotor firmly from turning
- Visually inspect that there is sufficient brake pad left on the calliper
- Manually release pressure on both brake valves to dump remaining pneumatic system pressure
- Measure and make note of thickness of all 4 brake pads
- Check all hoses for abrasion or cracking

Drivetrain

- Inspect rotor shaft, gearbox and generator casing for excessive corrosion or wear

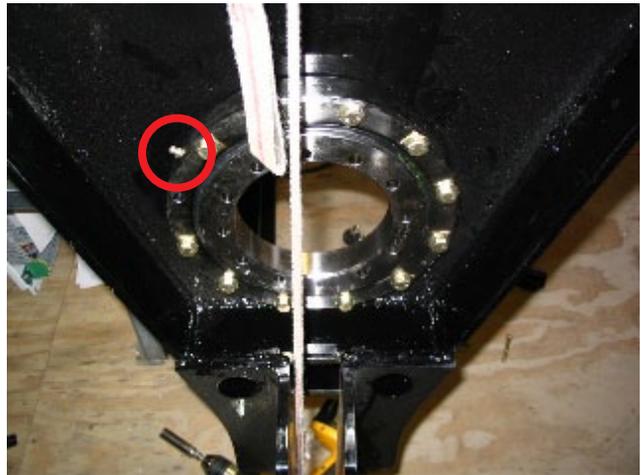
- Inspect gearbox seals for any sign of oil leakage
- Inspect gearbox torque link bushing for any signs of wear or cracking

Grease Bearings

- **Yaw bearing** – Kaydon turntable bearings are pre-lubricated with a lithium-based mineral oil grease conforming to NLG I No. 1 consistency with extreme pressure additives. As such, the Yaw Bearing should be greased only with products recommended by the manufacturer as listed below. It is recommended that enough grease be ‘pushed in’ until it starts to purge out.

Manufacturer Recommended Internal Bearing Grease Open Gear Grease

- BP Energrease LS-EP 1
- Castrol HD Lithium 1 Open Gear 800
- Chevron Dura-Lith EP 1 Chevron Open Gear Grease
- Exxon-Mobil Mobilux EP 1 Mobiltac 375NC (drum)
- Gearlube 375NC (spray can)
- Klüber Klüberplex BEM 41-141 Klüberplex AG 11-462
- Lubricants USA (FINA) Marson EPL 1 Marson Open Gear Lubricant
- Shell Alvania EP 1 Malleus GL
- Texaco Multifak EP 1 Crater 2X (asphaltic based)



- **Forward Pillow Block bearing** } #2 Lithium Complex compatible grease
- **Rear Pillow Block bearing** }

It is recommended that for the bearing on the small shaft (1 11/16” diameter) that 5-6 pumps of grease be used (each pump is around 1 cubic centimeter). For the larger shaft (2 3/16” diameter), 7-8 pumps of grease is sufficient. Of course if the grease begins to purge out prior to applying all the pumps, there is likely enough grease in the bearing and no more is required.



- **Generator bearings (2)** – There are 2 zerk locations on each side of the generator. **Only one of the zerks on each side requires grease.** One pump of a standard grease gun is sufficient.
- **LSS sensor mount** – Apply grease to the face and shaft of the LSS sensor mount.

The grease must be compatible with polyurea mineral oil NGL1 grade 2 grease. Some examples include:

- Chevron SRI #2
- Rykon Premium #2
- Exxon Polyrex EM
- Texaco Polystar RB

DO NOT OVER GREASE!



Table 1. Endurance S-Series Fastener Information

| Fastener Location | Size & Type | Quantity | Torque |
|---|--|--------------------|------------------|
| Tower/Winch base foundation | 1" Grade 5 galvanized nuts | 8 | 250 ft-lbs |
| Tower/Gin Pole Pivot | 1" x 11" Grade 8 zinc | 2 | Loose |
| Tower/Gin Pole Flange | 3/4" x 3.5" or 4" Grade 5 galvanized or zinc | 8 per flange | 250 ft-lb |
| Gin Pole End Plate | 3/4" x 2" Grade 5 galvanized or zinc | 1 | 250 ft-lb |
| Upper guy cable clamps | 1/2" galvanized cable clamps | 3 per guy wire end | 65 ft-lb |
| Lower/Middle guy cable clamps | 5/16" galvanized cable clamps | 3 per guy wire end | 30 ft-lb |
| Turbine to tower connection | 5/16" nuts Grade 8 zinc | 12 | 10 ft-lb exactly |
| Blade bolts | 3/8" x 4.5" Grade 8 zinc with nylock nuts | 12 (4 per blade) | 25 ft-lb exactly |
| Tail boom Mount to Mainframe | 3/8" x 3.25" Grade 8 zinc with nylock nuts | 2 | 35 ft-lb |
| Tail boom to Mount | 3/8" x 2.5" Stainless socket head with nylock nuts | 1 | 20 ft-lb |
| Tailplane to Tail boom | 3/8" x 2.5" Grade 8 zinc with nylock nuts | 3 | 20 ft-lb |
| Tailplane joint and nacelle bracket | 1/4" x 3/4" Grade 8 zinc with nylock nuts | 5 | 10 ft-lb |
| Nacelle cover support disk to mainframe | 1/4" x 1" Grade 8 zinc with nylock nuts | 4 | 10 ft-lb |
| Nacelle cover to support disk | 1/4"-20 x 3/4" stainless with bond seal washer | 4 | hand tight |
| Nose cone | 1/4"-20 nylock nuts with bond seal washer | 3 | hand tight |

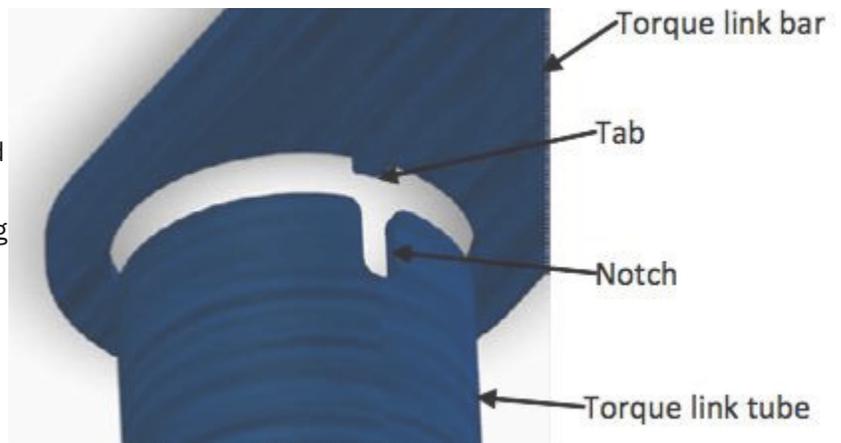
Inspect Pneumatic System Desiccant

- ❑ Replacement of the desiccant is recommended immediately prior to winter in climates prone to sub-freezing temperatures.
- ❑ The silica desiccant housed in the Desiccant Dryer can be reused once it has been spent. Spent desiccant will be pink indicating that it has absorbed moisture from the compressor system as opposed to the bright blue (no moisture absorbed). Drying the desiccant is a simple procedure and can be completed quickly. For instructions on how to dry the desiccant please refer to the [Reusing Spent Drier Desiccant](#) document, located on the Endurance website Dealer Portal.



Electrical

- ❑ Open J-box and check for any loose wires or signs of electrical problems
- ❑ Open electrical box on side of generator and check for loose connections
- ❑ Check for and replace any broken or missing zip ties along all wires runs
 - Check condition of visible portion of slip ring and its wires
- ❑ Inspect the slip ring torque link bar for signs of wear, especially where the tab that locks the torque link bar to the torque link tube. If there is wear on the bar, replace it. This requires you to disconnect and reconnect some wiring.



Yaw system

- ❑ Yaw bearing rotates freely
- ❑ Yaw lock pin secures turbine properly
- ❑ Clean up excess grease(a normal condition) around yaw bearing seals

Rotor

- ❑ Inspect blade leading edge tape for wear or loss of adhesion
- ❑ Check blades for any signs of cracks or other premature wear
- ❑ Ensure blades are secured between hub plates
- ❑ Check radial alignment of blade roots with hub plates or measure distance between blade tips

Reinstall nose cone, nacelle cover and tail

- ❑ Tighten fasteners properly and check torque
- ❑ Clean exterior of turbine of any excess dirt or other foreign matter

Tower Rigging - After raising tower back to upright and locked position

- ❑ Check security of all rigging, safety wire and pins on shackles and turnbuckles
- ❑ Check straightness and plumb of erect tower mast and adjust as necessary
- ❑ Check tension of guy wires and adjust as necessary

SECTION 5—TOOLS & SUPPLIES

The following tools and supplies are required for installing or servicing an endurance wind turbine.

Required Tools and Supplies

- Keys to control panel
- Turbine service cord
- Yaw Lock Pin
- Ratchet set with common extensions and sockets
- Box and open-end wrench set (up to 1-1/2")
- Flat and Phillips screwdrivers including one very small (1/8" blade) flat screwdriver for making control panel connections
- Full Allen wrench set (long)
- Electricians pliers
- Wire strippers
- Torque wrenches with capacities from 10 ft-lbs (13 Nm) to 250 ft-lbs (350 Nm) capacity (with socket sizes from 7/16" to 1-1/16")
- Spirit level (6" long is sufficient, magnetic preferred)
- 150 ft fish tape
- 100' Extension cord
- 50' measuring tape
- Cable (Haven's) grips for 1/2" and 5/16" wire rope
- Rope (150 ft)
- Come-along
- Bailing or safety wire
- Chain or tow straps with hook ends
- Sturdy, adjustable stands on which to rest tower and gin pole (e.g., railroad ties or other scrap lumber)

Recommended Tools and Supplies

- 4' stepladder for the vertically challenged
- Electric drill-driver with drive for sockets
- "Spud" or erector's wrench
- Hammer
- Sledge Hammer
- Shovel
- Mallet
- Common pliers
- Utility knife
- Small forked connectors for anemometer
- Rags
- Silicone sealant

- Pen or pencil for taking notes
- Installation and service manuals

Lowering or Raising Tools and Supplies

- Suitable winch or raising equipment
- Winch or raising cable of sufficient length (see Chart)
- 4 or 5 McKissick Tailboard Blocks
- Extra 1/2" Shackles (4)
- Back Haul Line (1/2" x 100')