

HSE Operation and Maintenance Manual

For CCTV Poles Lighting Poles High Masts and Special Application Poles

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Issued by Langfang Yaoxing Optoelectronic Technology Co., Ltd.

For system integrators, EPC contractors, site installation teams, independent inspection consultants and acceptance authorities.

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1 Scope and Responsibilities

1.1 Product Scope

By application

1. CCTV poles, including heavy-duty poles designed to applicable requirements, off-grid solar CCTV poles and poles for laser-equipped PTZ cameras.
2. Street lighting poles.
3. High mast lighting systems.
4. Special application poles, including multifunction poles for ports of entry, mines, border installations and chemical industrial parks.

By material

1. Hot-dip galvanized carbon steel.
2. Grade 304 or 316L stainless steel.
3. 6061-T6 or 6063-T6 aluminium alloy.

1.2 Standards and Compliance Basis

This manual draws upon well-established international engineering safety, material and corrosion standards including OSHA, EN, Eurocode, ISO 1461, IEC, ASCE and ISO-12944 C5-M corrosion classification. It provides general guidance and is not a certificate of third-party product compliance.

1.3 Responsibilities

1.3.1 Manufacturer Responsibilities

Verify manufacturing tolerances and mechanical properties of the pole material, flanges, welds, caged ladders, platforms and other primary structural components before dispatch. Supply material test certificates (MTCs) and structural calculations for wind and seismic loading as contractually agreed.

Apply the specified factory corrosion protection: a duplex system of hot-dip galvanizing and powder coating for carbon steel; pickling and passivation for stainless steel; and anodizing for aluminium alloy.

Factory-fit earthing terminals, internal cable management components and predrilled equipment mounting holes.

Supply tightening torque specifications, anchor bolt setting templates and the complete technical documentation package, including this HSE operation and maintenance manual.

Provide technical support and coordinate corrective measures for defects covered by the manufacturer's structural and corrosion protection warranties.

1.3.2 Site Contractor Responsibilities

Construct concrete foundations, assemble reinforcement cages, set anchor bolts, carry out anchor-bolt pull-out testing where required by project specification.

Lift and erect poles, set them plumb and level, tighten flange connection bolts in stages and install external earth electrodes.

Install electrical wiring, segregate power and signal cables, test insulation resistance and verify that measured earth resistance meets the applicable requirements.

Carry out periodic inspections, routine coating repairs, equipment additions, maintenance at height, dismantling and decommissioning.

Ensure personnel are trained and appropriately certified; provide PPE; monitor weather conditions; and maintain barriers and site safety supervision.

Comply with all HSE, environmental and electrical legislation applicable in the project country or region.

1.4 Prohibited Structural Modifications

Do not cut, weld, grind, drill or otherwise modify the pole shaft, flanges, caged ladders or other factory-supplied load-bearing components without authorization. Any structural modification requires written confirmation of the load change bearing the manufacturer's official company stamp. Unauthorized modifications invalidate all structural warranties, and the site contractor assumes full responsibility for any resulting safety risks.

1.5 Material Performance

Hot-dip galvanized carbon steel poles: protected by a duplex system of hot-dip galvanizing and exterior-grade powder coating, with a design service life of 30 years. Maintenance requirements are low in normal inland conditions. In coastal C5-M and chemically corrosive environments, repair damaged areas locally; full-pole recoating is not required.

304 and 316L stainless steel poles: the base material provides inherent resistance to chloride corrosion, substantially reducing periodic protective coating work. Do not expose the pole surface to aggressive cleaners containing chlorides or fluorides.

6061-T6 and 6063-T6 aluminium alloy poles: approximately one-third the weight of carbon steel poles of the same dimensions, with anodized corrosion protection. The material is non-magnetic and does not interfere with radar or communication signals. Observe the aluminium-specific requirements for galvanic corrosion, combustible aluminium dust and attack by strong alkalis.

2 Personnel Competence and Personal Protective Equipment

2.1 Personnel Requirements

All personnel working at height must complete appropriate safety training and be medically fit for the task, with no contraindications such as hypertension, heart disease or acrophobia. Do not work at height while fatigued, after consuming alcohol or while taking medication.

Electrical personnel must hold qualifications appropriate to the operating voltage. Welding and cutting personnel must hold the relevant certification.

A designated ground-level safety attendant must remain on duty throughout all work at height.

2.2 PPE by Task

Task	Minimum PPE	Additional protection
Ground-level inspection and foundation installation	Safety helmet, slip-resistant safety footwear and abrasion-resistant gloves	None
Work at height at 1.8 m or above	Minimum PPE plus full-body harness with twin-leg lanyard and energy absorber	For night work, provide at least 50 lx of lighting and red elevated-work warning lights

Task	Minimum PPE	Additional protection
Electrical wiring and distribution maintenance	Minimum PPE plus 1000 V insulating gloves and insulated tools	For lighting power circuits, also provide a voltage detector and capacitor discharge tools
Welding and hot cutting	Minimum PPE plus welding helmet, flame-resistant workwear and respiratory protection against dust	For carbon steel cutting, add respiratory protection suitable for toxic fumes; for aluminium cutting, provide a Class D extinguisher
Aluminium grinding and cutting	Minimum PPE	Cut-resistant gloves, safety goggles and a dust respirator to protect against flying swarf, cuts and dust inhalation
Luminaire maintenance	Minimum PPE	Anti-glare safety eyewear; do not look directly at an unshielded high-intensity light source

2.3 Mandatory PPE Requirements

Attach harness hooks only to secure, load-bearing structures such as the pole's caged ladder or top lifting lugs. Do not attach them to cameras, cables, access doors or other non-load-bearing components. Keep the anchorage above the user; do not use an anchorage below the user.

3 Weather Restrictions for Work at Height

Stop all maintenance at height and pole lifting or erection when the measured site wind speed is 10.8 m/s or higher (Beaufort force 6), or during thunderstorms, dense fog, rain, snow or icy conditions.

At a wet bulb globe temperature (WBGT) of 30 °C or above, implement work rotation and limit each person's continuous work at height to 30 minutes. Provide hydration and heat-stress supplies. In extreme cold, implement frostbite prevention and slip protection measures.

When a lightning warning is issued, move all personnel at least 50 m away from the pole and stop all pole-related work.

Before winter work, remove ice and snow from climbing steps and flange surfaces to prevent slips and falls.

Note: Local site HSE rules may specify lower wind-speed limits, which shall take precedence.

4 Installation Safety Requirements

4.1 General Installation Requirements

Do not erect a pole until the concrete foundation has reached the specified strength and the anchor bolts have passed pull-out testing. Early erection is prohibited.

Establish an exclusion zone for lifting operations. No person may stand beneath the suspended pole. Tighten flange connection bolts progressively in a diagonal sequence to the values in Appendix B. Do not fully tighten one side in a single pass or leave bolts under-tightened.

Do not substitute or reduce the size of cast-in anchor bolts without authorization. The total equipment weight and total projected wind area must not exceed the rated limits on the pole nameplate. Before adding heavy PTZ cameras, radar units or large LED displays, obtain updated structural calculations and written approval from the manufacturer.

Prepare a lifting plan identifying lifting points, rigging specifications and signalling procedures. Obtain approval from the site HSE manager before lifting. After initial securing of the pole, install temporary guy supports. Do not release the lifting gear until stability has been confirmed.

Additional Requirements for Aluminium Poles

Galvanic isolation: do not allow direct contact between aluminium flanges and carbon steel bolts. Use fasteners intended for aluminium applications wherever possible. Where carbon steel fasteners are used, fit nylon or EPDM insulating washers. Provide a bituminous or epoxy barrier between the aluminium base flange and highly alkaline concrete. Do not embed aluminium directly in concrete.

Lifting: the lower self-weight of aluminium poles may allow smaller lifting equipment. Do not use the pole tube wall as a lifting attachment point for heavy equipment, as local compression may cause permanent denting or deformation.

Additional Requirements for Lighting Poles High Masts and Multifunction Poles

Route power and signal cables separately in dedicated internal channels. Provide residual-current protection and miniature circuit breakers (MCBs) for 220 V/380 V AC power circuits. After luminaire installation, fully discharge any residual capacitor charge before closing the supply circuit.

LED luminaires and advertising displays can have large projected wind areas. For poles supporting multiple devices, calculate the combined wind load to prevent overloading and permanent deformation.

5 Periodic Inspection and Maintenance

5.1 Inspection Intervals

Normal inland environments without significant corrosion: carry out a comprehensive inspection once a year.

Coastal salt-spray locations, chemically corrosive industrial sites and C5-M environments: carry out a targeted inspection every six months.

After a typhoon, severe rainstorm, earthquake or similar natural event, complete a dedicated structural inspection as soon as practically possible within local site constraints, ideally within 24 hours after the event.

Lighting poles and high masts: prolonged wind-induced vibration of luminaires can cause bolt fatigue and loosening. Check the tightening torque of flange connection and equipment bracket bolts every three months.

Additional inspection for off-grid solar poles: Inspect PV-module mounting fixtures, wiring, battery enclosure sealing, torque of solar-bracket bolts. Confirm no over-loading / excessive wind-area added by solar arrays. Follow battery supplier maintenance & safety guidance.

5.2 Inspection Tools and Records

Provide a torque wrench, insulation resistance tester, illuminance meter and thickness gauge. Retain all inspection records in both paper and electronic form as key evidence for third-party acceptance. Keep records for at least 20 years.

5.3 General Defect Response

Only minor, superficial coating damage may be repaired locally on site. If the pole is bent, a weld is cracked, the foundation has settled or multiple bolts are missing, immediately take the pole out of service and establish an exclusion zone. Contact the manufacturer's structural engineer promptly to assess repair or replacement.

5.4 General Inspection Checklist

Item	Inspection	Acceptance criterion	Action if defective
Concrete foundation	Cracking and differential settlement	No visible cracks, displacement or settlement	Immediately take out of service and isolate
Flange connection bolts	Check tightening torque	Measured torque within $\pm 10\%$ of the design value	Retighten loose bolts and mark the reinspection date
Carbon steel corrosion protection	Integrity of galvanizing and powder coating	No blistering, peeling or rust staining	Prepare locally to St 3 and repair with the compatible factory coating system
Stainless steel surface	Pitting and salt deposits	No extensive corrosion or white staining	Rinse with clean water and neutral detergent; assess replacement if pitting is severe
Aluminium anodized layer	Chalking and white galvanic corrosion deposits	Anodized layer intact	Wash with neutral detergent; touch up scratches with a coating formulated for aluminium
Earthing connections	Breakage and severe corrosion	Conductors continuous, without corrosion damage or breaks	Replace corroded earthing transition terminals
Caged ladder and maintenance platform	Rungs, guardrails and fasteners	No deformation, cracks or loose components	Prohibit climbing until repaired
Top-mounted equipment brackets	Security of cameras, radar and luminaires	Securely fastened; total loading within limits	Remove excess equipment or reassess structural loading
Lighting pole ventilation openings	Blockage, dust and debris	Openings fully clear	Remove debris to prevent cable deterioration and fire from internal overheating

6 Access Ladders and Maintenance Platforms

Before climbing, visually inspect ladder rungs, safety cages, guardrails and connection bolts from ground level. Do not climb if any component is deformed or loose.

Use a twin-leg harness attachment system and maintain at least one secure, load-bearing connection while moving. Keep all tools in a tool bag. Never throw tools or components from height.

The uniformly distributed load limit for maintenance platforms is 200 kg/m^2 (as per project design). Do not allow several persons to congregate on the same platform level or store heavy equipment there.

After a typhoon or earthquake, inspect the complete ladder and cage assembly. Do not resume climbing until the assembly has passed inspection.

7 Electrical Safety Lockout Tagout and Earthing

7.1 General Electrical Requirements

Apply lockout/tagout (LOTO) for all electrical maintenance. Lock each isolation point and attach a “Do Not Energize” warning tag. Each worker must retain personal control of their isolation key.

After wiring or maintenance, verify insulation resistance in accordance with local electrical codes and equipment manufacturer requirements, typical minimum value 0.5 M Ω for low-voltage circuits. Prevent standing water inside the pole. Replace damaged access door seals to prevent short circuits and accelerated internal corrosion caused by water ingress.

The complete earthing system must meet local electrical codes and project- specified earthing resistance requirements. No universal fixed resistance value is specified within this manual. Inspect earthing connections for corrosion annually. Fit air terminals where required on exposed hilltops or open sites, and verify earthing continuity periodically.

Additional Electrical Requirements for Aluminium Poles

The oxide film on aluminium has poor electrical conductivity. Do not wrap a copper earthing conductor directly around the aluminium pole. Use a copper-to-aluminium transition terminal and apply a uniform layer of conductive jointing compound to prevent excessive contact resistance and heat that could melt the conductor during a lightning strike.

Additional Electrical Requirements for Lighting Poles and High Masts

Provide residual-current circuit protection in 220 V/380 V power distribution compartments. Before replacing a luminaire, use a multimeter to verify that its capacitors are fully discharged and no residual high-voltage shock hazard remains.

Aluminium lighting poles are non-magnetic. Internal communication and radar cables do not require additional electromagnetic shielding, making these poles suitable for multifunction smart intersection installations.

8 Corrosion Protection and Weld Repair by Material

8.1 Hot Dip Galvanized Carbon Steel Poles

Corrosion protection provides long-term performance in inland conditions. In coastal and chemical environments, locally prepare damaged coating areas to St 3 and repair them using manufacturer-compatible primer and topcoat. Do not grind large areas of intact factory galvanizing. Periodic full-pole recoating is not required.

Weld repair protection: remove rust from the weld, apply a thermally sprayed zinc base layer and finish with a weather-resistant topcoat. Do not return the pole to service until corrosion protection has been restored.

8.2 Grade 304 and 316L Stainless Steel Poles

The base material provides inherent resistance to salt-spray corrosion and does not require routine rust removal or full-pole painting. Remove surface salt deposits with clean water. Do not use aggressive acidic or alkaline cleaners containing chlorides or fluorides. If deep pitting occurs, assess the exposure conditions; extensive recoating is not required.

Weld repair protection: pickle and passivate after welding to address the risk of corrosion associated with chromium depletion at the weld.

8.3 Aluminium Alloy Poles

The anodized layer provides corrosion protection. Do not use strong acids, strong alkalis or chlorine-containing cleaners. Clean only with water and a neutral detergent. Touch up deep scratches with a repair coating formulated for aluminium. Do not grind off the protective oxide layer over the entire pole.

Weld repair protection: thoroughly remove welding residue and loose white oxide deposits. Wash with hot water and a neutralizing solution, then dry. Smooth the weld heat-affected zone using 800–1200 grit abrasive paper. In inland environments, apply an epoxy primer formulated for aluminium. In C5-M environments, use an epoxy primer and a weather-resistant polyurethane topcoat. Do not use the thermal zinc spray process specified for carbon steel, to avoid galvanic corrosion between dissimilar metals.

Mandatory Requirement for All Materials

After any authorized on-site weld repair, restore the corrosion protection around the weld in accordance with the requirements for the relevant material. Do not return the pole to service before this work is complete.

Additional Maintenance for Lighting Poles

Prolonged heat from luminaires can raise the internal pole temperature. At each inspection, remove cobwebs, leaves and debris from ventilation openings to reduce the risk of cable deterioration and fire caused by overheating.

9 Equipment Load Changes

9.1 Load Limits and Approval

Do not add cameras, radar units, sensors, displays or other equipment without authorization, or exceed the manufacturer's design limits for equipment weight and total projected wind area.

Before adding heavy PTZ cameras, long-range radar, large LED luminaires or advertising displays, obtain a written load change approval bearing the manufacturer's company stamp. Update the wind load and stability calculations at the same time. Verbal assurances do not constitute structural approval.

After acceptance of the load change, update the maximum permissible load on the pole nameplate. Maintain a minimum structural safety factor of 1.5 under all operating conditions.

Load Risks for Aluminium Poles

Aluminium alloys have lower yield strength than carbon steel and are susceptible to permanent bending when heavy equipment or equipment with a large projected wind area is added. For high-wind sites or installations supporting multiple devices, give preference to heavy-duty carbon steel poles designed to the applicable requirements.

Load Risks for Lighting Poles and High Masts

Continuous low-amplitude vibration during long-term LED luminaire operation can accelerate weld fatigue and connection bolt loosening. Check bolt tightening torques every three months. Large luminaires and advertising displays substantially increase wind loads. Reassess the complete set of wind load combinations whenever equipment is added.

10 Defect Classification and Emergency Response

10.1 Defect Classification

Class	Condition	Required response
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Class	Condition	Required response
A Critical	Visible pole lean or bending, cracked welds or severe foundation settlement	Establish an appropriate exclusion zone (minimum reference distance 50 m for tall poles). Prohibit approach and climbing. Contact the manufacturer within 24 hours to arrange an on-site technical assessment.
B Major	Multiple bolts missing, main earthing conductor broken or severe damage to mounted equipment	Restrict use. Complete repairs and reinspection within 72 hours
C Minor	Minor coating scratches, damaged door lock or minor abrasion of the cable outer sheath	Include in the next routine inspection and repair within the specified deadline

10.2 General Emergency Response

After a thunderstorm or typhoon, prioritize checks of earthing continuity and circuit insulation resistance.

If a fall from height, electric shock, equipment damage or another safety incident occurs, preserve site photographs and records of the time and any injuries. Report the incident in accordance with the project's local HSE procedures.

File all incident reports centrally, including the location, photographs or video, preliminary cause, corrective action plan and reinspection records.

11 Dismantling Decommissioning and Waste Management

11.1 General Dismantling Procedure

Before dismantling, fully isolate all power circuits within the pole and remove all top-mounted equipment. Prepare a dismantling plan and obtain approval from the site HSE manager before work begins.

Use lifting equipment throughout a controlled dismantling sequence. Do not use uncontrolled cutting or forceful hammering. Before hot cutting, remove all cables and combustible material from inside the pole. Provide suitable fire extinguishers and appoint a fire watch.

Cutting galvanized carbon steel produces hazardous zinc fumes. Personnel must wear respiratory protection suitable for toxic fumes and work upwind.

Additional Requirements for Aluminium Dismantling and Recycling

Airborne aluminium dust can explode if an ignition source is present at a sufficient dust concentration. Provide forced ventilation during cutting and grinding, and keep Class D extinguishers suitable for metal fires on site. Do not use water fire extinguishers for aluminium-metal fires. Prohibit smoking and open flames in the work area.

Aluminium has a high recycling value. Store decommissioned aluminium poles separately from carbon steel scrap and use a specialist non-ferrous metal recycler.

11.2 Waste Segregation and Disposal

Waste type	Disposal route
Carbon steel pole shafts and fittings	Conventional steel scrap recycler
Stainless steel poles and fittings	Specialist stainless steel recycler; segregate to retain scrap value

Waste type	Disposal route
Aluminium poles and profiles	Store separately and use a specialist non-ferrous metal recycler
Protective coating and repair paint waste	Dispose of in accordance with local hazardous waste regulations
Power cables and electronic components	Approved electrical and electronic waste recycling route
Concrete foundations	Construction and demolition waste disposal route

12 Maintenance Records and Traceability

Maintain a complete file containing installation and acceptance records, periodic inspection logs, repair and modification records, written load change approvals and safety incident reports.

Retain both paper and electronic records throughout the pole's design service life, for a minimum of 20 years, to support lifecycle traceability reviews by project owners and independent inspection consultants.

Electronic maintenance registers are recommended to support remote access for overseas projects and batch export for project submissions.

13 Appendices

Appendix A Site Inspection Record

Date	Inspector	Weather	Item	Result	Corrective action	Reinspection sign-off
			Concrete foundation	Pass / Fail		
			Flange connection bolts	Pass / Fail		
			Pole corrosion protection	Pass / Fail		
			Earthing connections	Pass / Fail		
			Caged ladder and platform	Pass / Fail		
			Top-mounted equipment	Pass / Fail		
			Aluminium anodized layer	Pass / Fail		
			Lighting pole ventilation and door seals	Pass / Fail		

Appendix B Reference Tightening Torques for Flange Connection Bolts

Bolt size	Property class	Recommended tightening torque N·m
M12	8.8	79
M12	10.9	110
M16	8.8	190
M16	10.9	270
M20	8.8	370
M20	10.9	530
M24	8.8	640
M24	10.9	910

Important Note: These are reference torque values for clean, dry, un-lubricated carbon-steel bolts. Hot-dip-galvanized fasteners, lubricated threads, special washers or coated fasteners will require adjusted torque values. Always follow project-specific engineering specifications. These values shall not supersede project drawing requirements.

Appendix C Emergency Technical Support Contacts

Contact	Details
24-hour emergency technical hotline	+86 150 0103 9818
Technical support email for overseas projects	yaoxingtech@gmail.com

Appendix D Technical Terms and Abbreviations

Term	Full form	Meaning
LOTO	Lockout/tagout	Electrical isolation and control procedure
PPE	Personal protective equipment	Equipment worn for personal protection
C5-M	Corrosivity category C5-M marine	Very high marine corrosivity category
WBGT	Wet bulb globe temperature	Heat stress assessment index
MTC	Material test certificate	Certificate documenting material test results
PMI	Positive material identification	Verification of alloy composition by spectrometric analysis
UT	Ultrasonic testing	Non-destructive examination using ultrasound
PT	Penetrant testing	Non-destructive examination for surface-breaking defects
Galvanic corrosion	Galvanic corrosion	Electrochemical corrosion when dissimilar metals are electrically connected in an electrolyte
Cu-Al transition terminal	Copper-to-aluminium transition terminal	Terminal designed to connect copper and aluminium conductors
Class D extinguisher	Class D fire extinguisher	Extinguisher suitable for combustible metal fires such as aluminium and magnesium dust

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