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BEST PRACTICES FOR THE UNMANNED AIRCRAFT AROUND CRITICAL INFRASTRUCTURE GUIDE

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Best Practices for the Unmanned Aircraft Around Critical Infrastructure Guide

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Users are responsible for ensuring that all UA operations comply with local laws, aviation regulations, and site-specific safety protocols. This includes obtaining necessary permits or consents, conducting risk assessments, and maintaining appropriate insurance coverage.

The use of Unmanned Aircraft (UAs) around critical infrastructure carries inherent risks. Operators must exercise professional judgment and adhere to all applicable standards to mitigate hazards to personnel, property, and the public.

Status of Examples and Case Studies

Examples, including sample processes, or case studies in this guide are included to assist with consideration of health and safety issues. The examples or case studies are not a comprehensive statement of matters to be considered, nor steps to be taken, to comply with any statutory obligations pertaining to the subject matter of this guide.

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- Utility UA Operators who shared field-tested practices and operational feedback
- Regulatory Authorities for providing guidance on airspace safety and compliance
- Technology Vendors and Integrators whose innovations continue to shape UA capabilities in infrastructure monitoring
- Industry Associations and Working Groups that promote knowledge-sharing and standardisation across the sector

Their collective expertise has helped ensure this guide reflects both practical realities and aspirational best practices for UAV use around critical infrastructure.

Preface

Unmanned Aircraft (UAs) are rapidly transforming how electricity networks are monitored, maintained, and protected. Their ability to access hard-to-reach infrastructure, capture high-resolution data, and operate in challenging environments makes them invaluable tools for utilities and contractors alike.

This document outlines common best practices for the use of UAs around critical electricity infrastructure. It is intended to support decision-makers, operators, and technical teams in selecting appropriate equipment, planning safe and effective missions, and complying with relevant regulations. While technologies and standards continue to evolve, the principles outlined here aim to promote safety, efficiency, and operational excellence across the sector.

The practices described are based on current industry knowledge and field experience. They are not exhaustive, nor do they replace formal training, certification, or regulatory guidance. Users should adapt these recommendations to their specific operational context and consult with relevant authorities where required.

The content and guidance contained within this document are intended for operations conducted under *Civil Aviation Rule (CAR) Part 101*. However, the principles and practices described herein reflect sound aviation safety practices and provide a robust foundation for progression to operations conducted under *CAR Part 102.*

Contents

Glossary and Acronyms

BGAN	Broadband Global Area Network: A satellite communication system that provides high-speed internet and voice connectivity in remote or infrastructure-limited areas. BGAN terminals are portable and commonly used in UA operations where cellular or terrestrial networks are unavailable.
BVLOS	Beyond Visual Line of Sight: UA operations conducted beyond the direct visual range of the pilot, requiring special permissions.
C&C Link, or C2 Link	Command and Control Link: The communication channel between the UAV and its ground control station or pilot. The C2 Link transmits flight commands, telemetry data, and system status in real time.
CAA	Civil Aviation Authority: The national regulatory body responsible for overseeing aviation safety, airspace management, and compliance with aviation laws. The CAA sets standards for UA operations, certification, training, and incident reporting.
CAR	Civil Aviation Rule: A set of regulations issued by the Civil Aviation Authority that govern aviation activities in New Zealand. CARs include specific parts relevant to UAV operations, such as Part 101 (general use) and Part 102 (certified operations).
Con-Ops	Concept of Operations: A strategic document outlining how UAs will be used within an organisation, including roles, procedures, safety protocols, and integration with existing workflows.
EVLOS	Extended Visual Line of Sight: A mode of UA operation where visual contact with the aircraft is maintained through one or more trained observers who relay information to the remote pilot. EVLOS allows for greater operational range while still complying with visual oversight requirements.
Failsafe	A system feature that ensures safe UA behaviour in case of signal loss or technical failure.
Flight Controller	The onboard computer that manages UA stability, navigation, and response to pilot inputs or autonomous commands.
FRTO	Flight Radio Telephony Operator: A qualification indicating competence to operate aeronautical radio equipment and conduct aviation radiotelephony communications using standard phraseology.
Geo-fencing	A virtual boundary that restricts UA flight to a predefined area for safety and compliance.
Gimbal	A pivoted support system that allows a camera or sensor to remain stable and level during UA flight, enabling smooth imaging and precise targeting.
GNSS	Global Navigation Satellite System: A satellite system that provides geolocation and time information globally.

IP Rating	Ingress Protection Rating: A standardised classification system (IEC 60529) that defines the level of protection an enclosure provides against intrusion from solid objects (like dust) and liquids (like water). Ratings are expressed as "IP" followed by two digits.
LED	Light Emitting Diode
LiDAR	Light Detection and Ranging: A remote sensing method that uses laser pulses to create high-resolution 3D maps.
OCA	Operational Competency Assessment: A formal evaluation process used to determine whether a UA operator is capable of conducting specific types of operations safely and in compliance with developed procedures.
Payload	The equipment carried by a UA, such as cameras, sensors, or communication devices.
Redundancy	The inclusion of backup systems (e.g., dual batteries, duplicate sensors) to ensure continued operation in case of component failure.
RGB	Red, Green, Blue: A colour model used in digital imaging and display systems where colours are created by combining varying intensities of red, green, and blue light. Commonly used in standard camera sensors and visual displays.
RPAS	Remotely Piloted Aircraft System: A broader term encompassing the UA, its control station, and communication links.
RTK	Real-Time Kinematic: A satellite navigation technique that enhances GPS accuracy to centimetre-level precision.
Telemetry	The automated transmission of data from the UA to the ground control station or handheld controller, including flight status, GPS location, battery levels, and sensor outputs.
Thermal Imaging	The use of infrared sensors to detect heat patterns, often used for fault detection.
UA	Unmanned Aircraft: An aircraft operated without a human pilot onboard, commonly referred to as a drone.
UTM	Unmanned Aircraft System Traffic Management: A digital framework developed to safely manage UA operations in shared airspace, especially below traditional controlled airspace. UTM systems coordinate flight planning, airspace authorisation, and real-time tracking to prevent conflicts and ensure compliance.
VLOS	Visual Line of Sight: A mode of UA operation where the remote pilot maintains direct, unaided visual contact with the aircraft at all times during flight. This ensures situational awareness and the ability to respond to hazards or unexpected conditions.

1. Operational and Purchasing Decisions

1.1 Craft Selection

Selecting the appropriate *UA (Unmanned Aircraft)* is a foundational decision that directly impacts the success, safety, and efficiency of operations around critical electricity infrastructure. Craft selection should be guided by a comprehensive understanding of mission objectives, environmental conditions, regulatory constraints, and technical requirements.

Operational and environmental requirement considerations

Choose UAs that align with the specific tasks, whether it's inspection, mapping, thermal imaging, or vegetation monitoring. Multirotor may be ideal for close-range inspections, while fixed-wing models offer longer endurance for wide-area surveys.

Consider the typical operating conditions such as wind, rain, temperature extremes, and electromagnetic interference near substations. UAs should be rated for the expected climate and terrain.

Ingress protection ratings are shown as IPXX where the Xs indicate the level of protection.

Level	First X - SOLID	Second X - LIQUID
0	No protection.	No protection.
1	Protected against a solid object greater than 50mm, such as a hand.	Protected against water drops.
2	Protected against a solid object greater than 12.5mm, such as a finger.	Protected against water drops at a 15-degree angle.
3	Protected against a solid object greater than 2.5mm, such as a wire.	Protected against water spray at 60-degree angle.
4	Protected against a solid object greater than 1.0mm, such as a thin strap.	Protected against water splashing from any angle.
5	Dust protected. Prevents ingress of dust sufficient to cause harm.	Protected against water jets from any angle.
6	Dust tight. No ingress of dust.	Protected against powerful water jets and heavy seas.
7		Protected against the effects of temporary submersion in water. (30 minutes at 3 feet)
8		Protected against the effects of permanent submersion of water. (Up to 13 feet)
Example: **IP65**	**6** – Dust tight. No ingress of dust. **5** – Protected against water jets from any angle.	

Key technical considerations

- Payload Capacity

  The UA must support the weight of required sensors and attachments without compromising flight stability or flight duration. This includes cameras, LiDAR units, thermal sensors, and communication modules.

- Flight Time and Range

  Longer battery life and extended range are critical for inspecting remote or expansive infrastructure. Consider swappable battery systems or hybrid power options for extended missions.

- Weather Resistance

  Look for IP-rated UA that can operate in light rain, dust, or high humidity. Weatherproofing is essential for year-round reliability.

- Sensor Compatibility

  Ensure the UA platform supports modular payloads and integrates seamlessly with mission-specific sensors. Compatibility with third-party software for data processing is also a plus.

Additional considerations

- Ease of Use and Training Requirements
- Opt for UAs with intuitive controls and robust training support. This reduces onboarding time and minimises operational errors.
- Maintenance and Support
- Evaluate the availability of spare parts, manufacturer support, and local servicing options. A well-supported UA reduces downtime and ensures long-term viability.
- Data Security and Storage
- For sensitive infrastructure, prioritise UAs with encrypted data transmission and secure onboard storage. This protects against data breaches and unauthorised access.

1.2 Operational Requirements

Defining the operational requirements of UAs is essential for aligning craft capabilities with mission objectives. Electricity networks demand a range of UA applications, from routine inspections to emergency response, and each use case requires specific sensor configurations, flight profiles, and data outputs.

Clearly articulating the intended mission helps guide equipment selection, flight planning, and data processing workflows.

The lead of the UAV programme is responsible for the overall management of a company's UA programme.

Below are common UA applications in electricity network operations:

1.3 Mapping

The purpose is to create accurate geospatial representations of terrain, infrastructure, and vegetation.

Requirements

- High-resolution RGB cameras with geotagging capabilities
- GNSS systems with RTK (Real-Time Kinematic) or PPK (Post-Processed Kinematic) for centimetre-level accuracy
- Flight planning software for grid or corridor mapping

Applications

- Asset inventory and location tracking
- Pre-construction surveys and route planning
- Vegetation encroachment monitoring
- Modelling or tracking land displacement

1.4 Thermal

The purpose is to detect heat anomalies that may indicate faults, overloads or failing components.

Requirements

- Calibrated infrared sensors with adjustable emissivity settings
- Dual-sensor payloads or sensors (RGB + Thermal) for visual context
- Real-time streaming for immediate fault identification

Applications

- Hotspot detection in transformers, insulators, conductors and photovoltaic systems.
- Preventative maintenance and fault diagnosis
- Post-event inspections (e.g., after lightning strikes or overloads)

1.5 High-Res / Zoom Optics

The purpose is to conduct detailed visual inspections from safe standoff distances.

Requirements

- Optical zoom cameras (20x or higher) with image stabilisation
- Gimbals with precise tilt/pan control for targeting
- High frame-rate video for capturing fast-moving actions or components (optional)

Applications

- Close-up inspections of insulators, conductors, connectors and tower structures
- Condition assessment without requiring physical access
- Compliance documentation and reporting
- Line-of-sight survey for substation radio systems

1.6 LiDAR

The purpose is to generate 3D models and point clouds for structural analysis and vegetation management.

Requirements

- UA-compatible LiDAR sensors with high pulse rates and range
- GNSS/IMU integration for accurate georeferencing
- Software for point cloud classification and modelling
- Higher pulse rates, High returns gives better density

Applications

- Clearance analysis between conductors, buildings, roadways and vegetation
- Tower geometry and deformation monitoring
- Terrain modelling for access planning and erosion studies
- 3D modelling of outdoor structures (substations)

1.7 Additional Equipment

Equipping UA teams with the right support gear is essential for maximising mission success, especially in remote or high-risk environments. These tools enhance safety, extend operational range, and improve data quality.

1.7.1 Portable Power Supply

The purpose is to enable battery recharging in the field, reducing downtime and supporting extended missions.

Recommendations

- Use rugged, high-capacity power banks or portable generators compatible with UA charging systems
- Consider solar charging options for multi-day operations, or lower power drain devices in remote areas
- Ensure power supplies are rated for outdoor use and have overload protection

1.7.2 Satellite Internet

The purpose is to provide connectivity for real-time data transfer, remote coordination, live video streaming and cloud-based processing.

Recommendations

- Use compact satellite terminals (e.g., Starlink or BGAN) with sufficient bandwidth for telemetry and video streaming
- Consider secure transmission protocols to protect sensitive data
- Test connectivity in advanced for known coverage gaps

1.7.3 Airband Radio (Receivers)

The purpose is to allow monitoring of air traffic and nearby aircraft, especially in controlled airspace creating an additional layer of situational awareness.

> **Note:** Transmitting on airband radio requires additional certification and requirements such as a Flight Radio Telephony Operator certificate (FRTO), receiving or listening does not.

Recommendations

- Equip teams with handheld airband radios or receivers

1.7.4 RTK Base Station

The purpose is to enhance GPS accuracy for precision mapping, inspection, and modelling tasks where a remote or network station may not be available.

Recommendations

- Deploy RTK base stations with known geodetic coordinates for consistent positioning
- Ensure compatibility with UA GNSS receivers and data processing software
- Use secure mounting and shielding to prevent interference or tampering

Alternative

Use a Network RTK service such as *PositioNZ* operated by *Land Information New Zealand* (requires mobile data).

1.7.5 Signage

The purpose is to alert staff and the public to active UA operations, promoting awareness and safety.

Recommendations

- Use portable signs or cones with clear messaging and visual icons
- Place signage at access points, work zones, and near critical infrastructure
- Include contact information for the UA team in case of inquiries or emergencies

1.7.6 Additional Attachments

Spotlights / Lights

The purpose is to improve visibility during low-light operations and enhances UA orientation.

Recommendations

- Use LED modules with adjustable brightness and beam direction
- Ensure lights do not interfere with sensor performance

1.7.7 Obstacle Sensor / Avoidance

The purpose is to enhance flight safety by detecting and avoiding obstacles in real time.

Recommendations

- Use multi-directional sensors (ultrasonic, LiDAR, or visual) for comprehensive coverage
- Calibrate sensors before each mission and monitor performance during flight

1.7.8 Speaker attachments

The purpose is to enable audible communication (typically one-way) with people on the ground to support operational coordination, situational awareness, and safety during flight operations.

Recommendations

- Use speakers with sufficient output and clarity to be intelligible at the intended operating altitude and ambient noise levels
- Pre-record standard messages where practicable to reduce pilot workload and ensure consistency

1.7.9 Additional Considerations

- Insurance requirements for equipment and public liability
- Ongoing costs to maintain drone program (for budgeting purposes) e.g. maintenance, subscriptions, software, upgrades or replacement of UA

2. Craft Identification

Proper identification of UAs is essential for operational transparency, regulatory compliance, and public reassurance. All UAs should be clearly marked and traceable to their operator or organisation.

2.1 Identification

Permanent Markings

Each UAV should have a durable, weather-resistant label affixed to its body. This label must remain legible throughout the craft's operational life.

Required Information

- UA registration number or identifier
- Operator name or organisation
- Contact number

Placement

Labels should be placed in a visible location, ideally on the top or side of the craft, without obstructing sensors or flight-critical components.

In addition to labelling the UA, operators should ensure their contact details are available on any ground control station, signage, or support vehicle present during operations.

Contact details should include a direct line for incident reporting or public inquiries, especially when operating in populated or sensitive areas.

3. Consent and Notification

Operating UAs in areas where individuals, property, or sensitive environments may be affected requires proactive communication and, in some cases, formal consent. This section outlines best practices for engaging stakeholders.

3.1 Methods and Processes

Direct Consent

When operating over private property or near individuals, CAR Part 101 requires an operator to obtain consent from the relevant parties. Consent can be written or verbal but should be recorded.

3.2 Lead Times

Standard Notification Period

Provide at least 48-72 hours' notice for non-urgent operations. For sensitive or high-impact activities, aim to extend this to 5-7 days.

Emergency or Rapid Deployment

In cases where UAs are deployed for emergency response or urgent inspections, notify stakeholders as soon as practicable.

3.3 Customer Engagement

Clearly explain the scope and intent of UA operations to clients or affected parties. Include details on data handling, privacy safeguards, and operational boundaries. Offer a channel for feedback or complaints, such as a dedicated email address or online form.

For recurring operations in the same area, consider hosting informational sessions or distributing educational materials to build trust and understanding.

Use of media release to notify customers eg Company website, texts (using ICP information for cell phone numbers), Letter drops, social media etc

3.4 Other notifications

Where applicable, operators should notify relevant external stakeholders, including the Department of Conservation (DoC), Iwi authorities, schools, Waka Kotahi NZ Transport Agency (NZTA), KiwiRail, Defence, and aerodrome operators, to ensure awareness of planned unmanned aircraft operations and to address any site-specific constraints or sensitivities.

Department of Conservation

Flying a UA over Department of Conservation (DOC) land in New Zealand requires adherence to both Civil Aviation Authority (CAA) Part 101 rules and specific DOC permitting processes. Common requirements for operations over DOC land include:

– Permit or concession: You must apply for a permit (concession) from the Department of Conservation to take off, land, or use a UA on public conservation land. Separate, specific permits are required for recreational, commercial, or research purposes.

– Wildlife Protection: UA use is restricted near seal colonies and marine mammal areas. Seasonal bans are often in place, particularly from December through February in sensitive areas. Even with a permit, you must maintain safe distances, often requiring operators to avoid disturbing wildlife or visitors.

Aerodromes

You must not fly a UA within 4km of the boundary of any aerodrome (including helipads) without prior authorisation, you must also be the holder of, or under the supervision of the holder of a recognised qualification or licence.

Flights require air traffic control (ATC) approval in controlled airspace, or in uncontrolled airspace an agreement with airport operator and an observer.

An exemption to this rule is to operate shielded with a barrier. A barrier in this case must physically separate the UA from the aerodrome by a barrier that is capable of arresting the flight of the aircraft. In this case the qualification, observer and approval (or agreement) are no longer required.

4. Training

Competent UA operation hinges on thorough training. Whether for recreational use, commercial deployment, or advanced applications, operators must demonstrate proficiency, safety awareness, and regulatory compliance. This section outlines pathways for training and ongoing skill development.

4.1 In-House

Internal Programs

Organisations may develop their own training modules tailored to specific operational needs, equipment types, and environments.

Curriculum Essentials

- UAV flight theory
- Aviation regulations and airspace awareness
- Emergency procedures and risk mitigation
- Equipment handling and maintenance basics
- Privacy obligations
- Battery management, transport and storage
- Incident reporting

Assessment

Include practical flight assessments and written evaluations to ensure operator readiness.

4.2 Third-Party Provider (Part 141)

Certified Training

Engage with Civil Aviation Authority (CAA)-certificated Part 141 training organisations for formal instruction.

A list of certificated part 141 training providers is available on the CAA website.

Benefits

- Structured curriculum aligned with national standards
- Access to experienced instructors and certified facilities
- Recognition for commercial or advanced operations

Course Types

- CAR Part 101: Understanding the regulations and developing a basic grasp of UA capability and control
- CAR Part 102: Advanced regulatory understanding, planning and mission execution
- Payload or craft-specific training (e.g., LiDAR, thermal imaging, mapping, etc)

4.3 Continued Competence

Refresher Training

Operators should undergo periodic refresher courses, especially when adopting new equipment or operating in unfamiliar environments.

Flight Hours

Maintain a logbook of flight hours and mission types to track experience and identify areas for improvement.

Peer Review

Encourage peer evaluations or team debriefs to share lessons learned and improve operational standards.

4.4 Moving to Part 102

Advanced Certification

For organisations or individuals seeking to conduct complex or high-risk operations, transitioning to a CAR Part 102 certification is recommended.

Requirements

- Comprehensive risk assessment and mitigation strategies
- Detailed operational procedures and safety protocols
- Demonstrated competence through training and flight experience

Application Support

Consider consulting with aviation advisors or legal experts to prepare a robust CAR Part 102 manual and application.

5. Maintenance

Routine and responsive maintenance is critical to ensuring UA safety, reliability, and in some cases regulatory compliance. A well-maintained craft reduces operational risk and extends equipment lifespan. This section outlines best practices for managing UA maintenance.

5.1 Maintenance Providers

- Manufacturer-Authorised Service Centres: Whenever possible, use service providers approved by the UA manufacturer to ensure parts and procedures meet original specifications.
- Third-Party Technicians: If using independent providers, verify their experience with your specific UA model and ensure they follow documented maintenance protocols.
- In-House Maintenance: Organisations with technical capacity may perform basic maintenance internally, provided staff are trained and procedures are documented.
- Post maintenance flight test: Before returning a craft to service following maintenance or repair, a test flight should be conducted in a controlled environment to confirm that the basic operation of the craft and its controls is correct and effective.

5.2 Maintenance Frequency

Scheduled Maintenance

- Follow manufacturer-recommended service intervals (e.g., every 50 flight hours or quarterly).
- Include pre-flight and post-flight inspections as part of standard operating procedures.

Event-Driven Maintenance

- Conduct immediate checks after hard landings, collisions, or exposure to extreme weather.
- Replace components showing signs of wear, corrosion, or performance degradation.

Battery Care

- Monitor charge cycles and replace batteries nearing end-of-life thresholds.
- Store batteries in cool, dry conditions and avoid overcharging or deep discharge.

6. Record Keeping

6.1 Maintenance Logs

Maintain a digital or physical logbook for each UAV, detailing service dates, performed tasks, replaced parts, and technician notes.

Compliance Documentation

– Ensure records are accessible for audits, insurance claims, or regulatory reviews

– Include calibration certificates for sensors and payloads where applicable

Flight Logging

Each flight should be logged with the UA's unique identifier, including time, location, and pilot/operator details.

Fleet Management

For organisations operating multiple UAs, a centralised database should track each craft's specifications, maintenance history, and operational status.

Consider using software tools to automate reminders, track service history, and manage inventory of spare parts.

6.2 Internal Document Library

Including but not limited to

– Flight plan applications

– Flight plan for operators

– Letter drop templates

– Checklist for entire process from application to closing task

– Company apps - recording drone tasks including risk management, Part 101 requirements and company job pack details, maintenance checks

– Company drone policy including risk matrix

7. Data Governance and Cyber Security

UA imagery and telemetry should be treated as business records. Define ownership, classify sensitivity, and store data in approved systems. Apply access controls, encryption at rest and in transit where practicable, and define retention periods consistent with legal and operational needs (including Privacy Act obligations).

When using third-party processing or cloud services, ensure contractual controls for data location, subcontractors, incident notification, and right to audit. Avoid storing sensitive data on removable media without safeguards.

8. Reporting

Accurate and timely reporting is essential for maintaining accountability, ensuring regulatory compliance, and contributing to a culture of safety and continuous improvement. This section outlines the key reporting obligations and recommended practices for UA operators.

8.1 CA005RPAS

The purpose is that the Civil Aviation Authority (CAA) requires the submission of a CAR Part 101/102 Occurrence Report (CA005RPAS) for any incident or accident involving a UA that affects safety.

When to Report

- Loss of control or flyaway incidents
- Near misses with manned aircraft
- Equipment failure affecting flight safety
- Breach of airspace or operational limits

How to Report

- Complete the CA005RPAS form available on the CAA website
- Submit within 10 working days of the incident
- Include detailed descriptions, flight logs, and any supporting media (e.g., video, telemetry)

Follow-Up

- Cooperate with any CAA investigations
- Implement corrective actions and update internal procedures as needed

8.2 WorkSafe – Notifiable Incidents

Applicability

If a UA operation results in serious injury, harm, or a near-miss that could have caused serious harm, it may be notifiable under WorkSafe New Zealand regulations.

Examples of Notifiable Events

– Injury to a person caused by UA impact or equipment failure

– UA causing damage to property or infrastructure

– UA operations contributing to a hazardous workplace event

Reporting Process

– Notify WorkSafe as soon as possible after becoming aware of the incident

– Submit a written report within 7 days

– Maintain records of the incident, including witness statements and risk assessments