# Skydio X10 Emergency Procedures

This statement describes the emergency procedures for the Skydio X10.

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Skydio aircraft feature automated contingency behaviors and offers options for pilot control during off nominal events.

Skydio support articles include:

- Understanding Skydio X10 contingency behaviors: https://support.skydio.com/hc/en-us/articles/20369897193883-Understanding-Skydio-X10-contingency-behaviors
- How to set Return and Lost Connection behaviors on Skydio X10: https://support.skydio.com/hc/en-us/articles/20283184685851-How-to-set-Return-and-Lost-Connection-behaviors-on-Skydio-X10

## Health Monitoring

Onboard systems automatically monitor health. Based on critical faults and system state, the aircraft control system may abort launch, execute an automatic emergency landing, or return to the home point (launch pad).

The system displays alerts and warnings as shown in the example below. Alerts are persistent and visible no matter how the operator has the Fly screen configured. If multiple alerts occur at the same time, they will stack themselves the order they occurred on the right hand side of the screen.

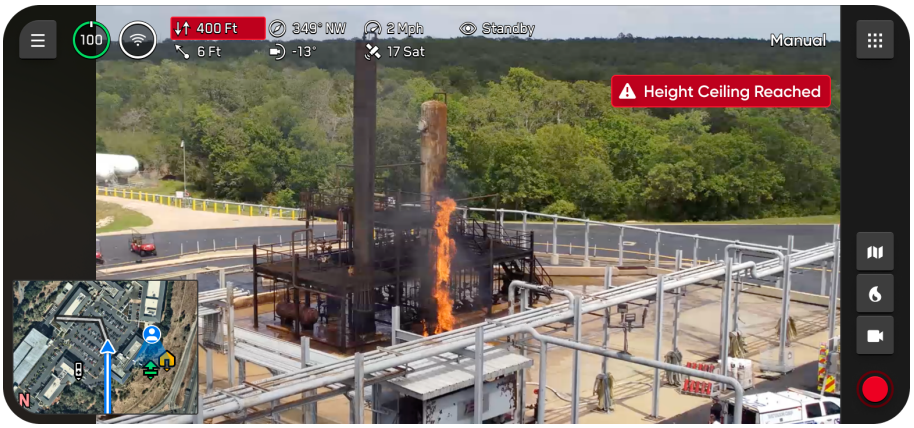


Figure 1 Alert example

## Operator Control

At any time, the operator may command the aircraft to return to the launch point, or land in place.

- A “HOME” button is located on the GCS. The Remote Pilot simply pushes either button and the aircraft immediately begins executing the Return Behavior. Full collision avoidance remains active during the return maneuver.
- A “Hold to LAND” button is located on the GCS. The Remote Pilot press this button and then confirm the selection. The aircraft begins descending to approximately 10 feet with full collision avoidance. Below 10 feet, the aircraft disables collision avoidance and continues descent until touchdown. The motors are then automatically disarmed.

The live camera feed enables the operator to view the landing area during Return Behavior and landing.

### Flight Termination

In addition to the Return Behavior capabilities mentioned above, the Remote Pilot can also initiate flight termination in the event of extreme emergency. To execute this action, the Remote Pilot simultaneously presses and holds the C3 and LAUNCH/RETURN/LAND buttons on the controller for 3 seconds.

A warning message will show during these 3 seconds. After 3 seconds, the sUA motors will stop and the aircraft will fall to the ground.

## C2 Monitoring and Contingency Actions

### C2 Monitoring

The GCS plays an important role in the command and control system. Link health metrics are summarized and displayed through the GCS. The image to the right shows Flight Deck Connections Menu and **Error! Reference source not found.** shows the Remote Flight Deck Connections Menu. The Remote Pilot can also view the Connections menu for additional information on connection health.

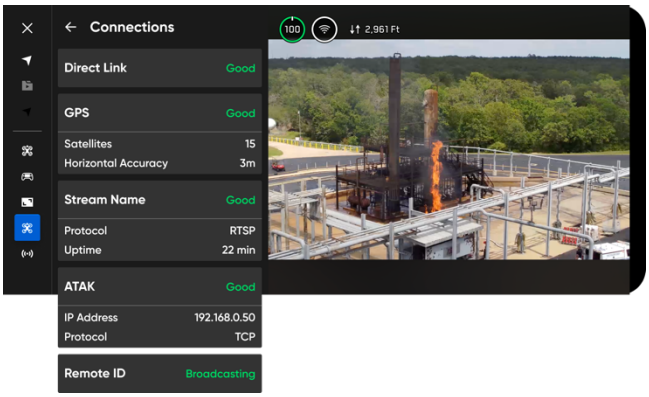


Figure 2 Connections Menu – Flight Deck

### C2 Degradation

The Remote Pilot can detect a C2 degradation by a drop in real-time video quality or delayed control input.

At this point, a Remote Pilot should navigate the aircraft to an area of better signal (closer to the controller, in a known area of cellular coverage, away from objects that attenuate signal). The Remote Pilot can use a combination of real time video feed, the moving map display, and the telemetry feed to determine distance and altitude of the vehicle relative to the take-off location. The displayed location is computed using a fusion of computer vision and GPS, enabling location updates even when the vehicle is operating in a GPS-denied environment, such as underneath the deck of a bridge.

### C2 Lost Connection

While the system has been optimized to maintain a link whenever possible, all wireless systems are subject to interference and/or attenuation. As such, it is important that the vehicle has a well-defined lost link procedure.

If the aircraft loses C2, the pilot will receive a visual alert on the GCS. Upon losing C2, the aircraft immediately begins to execute its Return Behavior maneuver as follows:

1. The aircraft will attempt to re-establish connection and begin the Link Timeout (configurable by the operator)
2. If the aircraft is executing a skill, it will continue the skill during the Link Timeout timer. If it is in Manual Mode, it will stop and hover in place during the Link Timeout timer.
3. When the Link Timeout timer expires, the aircraft will execute the Return Behavior as configured by the operator before flight.
4. The aircraft will execute an automated landing at the Return location

The autonomy engine plans a safe path using its knowledge of the surrounding environment, allowing it to traverse complex environments. Even if the vehicle is operating in a GPS-denied environment, it can return to a known safe location using visual state estimation capability.

## Propulsion System Fault/Failure

Several parameters related to the motors, motor controllers, and the power distribution board are monitored.

**Pre-Launch**

If the aircraft experiences a propulsion system component fault or failure during takeoff prechecks, the following steps are taken:

1. Attempt to resync motors
2. Attempt to restart motors
3. Shut down all motors

The aircraft will not take off if the system detects and cannot clear a fault in the propulsion system. A ‘motor spin up failure’ message will be displayed via the GCS.

**During Flight**

If the aircraft experiences a propulsion system component fault or failure during flight, the system will attempt an automatic emergency landing sequence in place, straight down. The control system will attempt to stabilize the aircraft throughout this maneuver. If a component failure renders flight uncontrollable, the vehicle will disarm the motors if pitch or roll exceeds 90 degrees for > 1 second.

# Battery Faults/Errors

The battery current and battery communication with the aircraft system is monitored.

**Pre-Launch**

If the aircraft experiences a battery fault/error during takeoff prechecks, the system will attempt to reset the battery. The aircraft will not takeoff if the system detects and cannot clear a fault in the battery.

**During Flight**

If the aircraft experiences a battery fault or failure during flight, the system will attempt an automatic emergency landing sequence in place, straight down.

# Environmental Warnings

## Battery Temperature Warning

The battery temperature by Skydio Autonomy.

- If the battery is too cold, the aircraft will not take off. If the battery becomes too cold during flight, low battery warnings may be experienced sooner than anticipated. In both cases, a low temperature warning is issued to the operator.
- If the battery is too hot, the aircraft will not take off. If the battery becomes too warm during flight, the following will occur:
  1. If high temperature is reached, issue high temperature warning to operator
  2. If a critical temperature is reached, issue a critical temperature warning to the operator, execute automatic emergency landing sequence.

The operator should discontinue the flight whenever temperature warnings are displayed on the GCS.

## Other Systems/Devices

The temperature of the compute devices onboard the aircraft are monitored. If any devices are too hot, the aircraft will not take off. If critical temperature is reached during flight, a critical temperature warning is displayed to the operator via the controller app. The system will execute an automatic emergency landing sequence in place, straight down.

If the mobile device overheats and powers down, this results in a loss of the communications link.

# Loss of Navigation Systems

If the system suffers a complete navigation failure, the aircraft will engage a recovery or landing sequence based on the nature of the failure. Degraded system performance or emergency landing notifications are displayed to the operator via the controller app. The following will occur:

- If visual sensing is available, the system will attempt a “smart landing” in which the aircraft will look for a flat surface clear of obstacles on which to land.
- If the planning subsystem has failed, the aircraft will engage an automatic emergency landing sequence in place, straight down.
- If the main processor has failed, a lower-level system will hover the aircraft on GPS while recovering the main processor.
    - If there is no visual or GPS state estimate available, the aircraft will engage an automatic emergency landing sequence based on state estimation using the barometer (altimeter) and rates and accelerations from the inertial measurement unit (IMU).

If functionality of the navigation computer is restored during descent, the emergency landing will be aborted, and the aircraft will hover in place. The operator may choose to resume the mission at their discretion.

## Loss of GPS

The GCS displays the GPS status, number of satellites, and GPS accuracy.

**Daylight Operations**

In the event the Skydio X10 loses GPS signal during daylight operations and below 33 feet, the aircraft will continue flying as normal using Visual Inertial Odometry. The Remote Pilot will even be able to execute the Return Behavior and fly to waypoints, however waypoint navigation will be less accurate.

In the event the Skydio X10 loses GPS signal during daylight operations above 33 feet or above large bodies of water, the aircraft may initiate an emergency landing if there are no features for the visual system to localize on.

**Night Operations**

In the event the Skydio X10 loses GPS signal during night operations, the Remote Pilot will receive a warning on the GCS and the aircraft will execute an emergency landing. The emergency landing consists of a steady descent to the ground where it will then disarm. The Remote Pilot retains limited controllability to guide the sUA to a safe landing location.

## Battery Indicator and Low Battery Behavior

The battery indicator is displayed in the upper left of the GCS. The system dynamically calculates estimated flight time remaining based on the aircraft’s distance from the Remote Pilot, altitude, and the time needed to land. The battery gauge states are as follows:


During normal operations, the battery indicator displays a percentage of overall battery remaining. The colors around the number represent:

- **Green** – battery capacity for nominal flight before it's time to return and land
- **Yellow** – indicates how much battery capacity is required to safely return. It is dynamic – as you fly away from the return location it increases and as you fly toward the return location it decreases.
- **Red** – indicates how much battery capacity is required to land. It is dynamic – as your height increases, it increases and as you decrease height, it decreases.


When battery capacity has less than two minutes of flight time available for landing, the indicator will change to a countdown

When battery capacity is zero, the indicator will change to an alert symbol and the aircraft will initiate a non-cancellable landing

When the sUA estimates it has two minutes of flight time left based on current altitude and distance from landing location, it will start a two-minute countdown. After the two-minute countdown, the sUA will initiate an automatic landing that is not cancellable. The Remote Pilot retains limited control capability (lateral) to land the sUA in a safe location.

## Abnormal Attitude Motor Disarm

The system will disarm the motors if pitch or roll exceeds 90 degrees for > 1 second.