RBAT System User Manual

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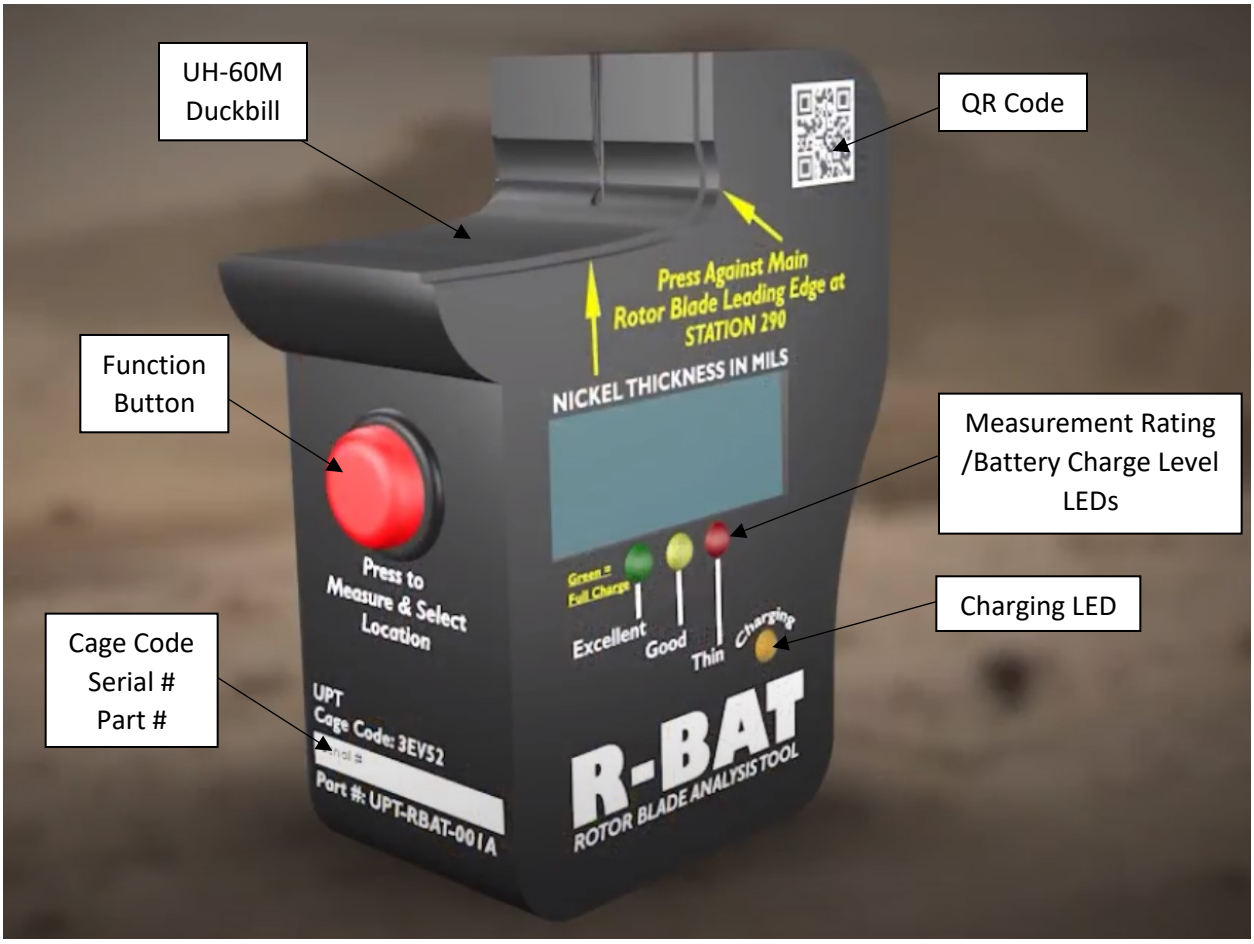
The UH-60M Blackhawk is the U.S. Army's primary medium-lift, multi-mission helicopter and operates in some of the most challenging take-off and landing environments on Earth. These ground environments can cause high levels of erosion to the leading edge of the aircraft's main rotor blades. Whether preparing for a critical mission or for a training exercise, it is highly important to prepare the aircraft for operation in these extreme environments.

Lack of aircraft preparation can lead to expensive and difficult field repairs, as well as reduced ready to fly rates. In an effort to mitigate these challenges, the Utility Helicopter Program Office has developed a device that precisely measures the thickness of the nickel erosion strips on UH-60M Blackhawk rotor blades. The Rotor Blade Analysis Tool ("R-BAT") provides an accurate indication of the strip's condition, giving aircraft technicians the ability to easily spot check a blade or retain data for future use, going well beyond a traditional visual inspection. Based on the thickness of the Erosion strips, decisions can then be made as to whether the blade is ready for fielding or should be further serviced before continued use.

1. R-BAT System Kit

The R-BAT system kit is delivered in a durable padded case with compartments for each component. It contains the R-BAT measurement device, a calibration key, a charging cable and power adapter, a lanyard, and a quick reference guide.

Externally, the front of the R-BAT has a digital display panel, 3 charge state and nickel thickness LED indicators, a charging LED indicator, and a QR code for information site access. The top of the unit includes a duck bill interface designed specifically for UH-60M rotor blades and a calibration key slot. The right side has a power switch and a micro-USB charge port. The back of the R-BAT has general step-by-step usage instructions. And the left side has a function button, along with printed model and serial numbers.



1.1. R-BAT Charging

When the R-BAT switch is pressed to the “on” position, the LEDs and display panel will cycle. After the cycle is complete, the red, yellow, and green LEDs will display as battery indicators. A red blinking LED along with “batt” on the display panel indicates that the battery needs to be recharged for 4 hours. A yellow blinking LED indicates that the battery is low and should be charged. If the green LED is illuminated, the R-BAT is fully charged. If no LED lights illuminate, recharge the battery for 4 hours.

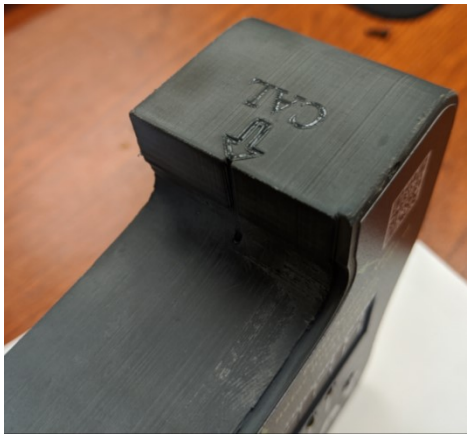
To recharge the R-BAT battery, press the power switch to the “off” position. Use the supplied USB charger by plugging the cable into the USB charge port located beside the power switch. Once the charger is plugged in, the LED labeled “charging” will illuminate. When the LED turns off, the charge is complete. Unplug the USB cable from the R-BAT charge port and switch the power “on” to determine the state of the charge. It can take a full 4 hours to charge the R-BAT.

1.2. R-BAT Calibration

Once the R-BAT is charged, it is ready to be calibrated and prepared for measurements. First, however, allow the R-BAT to acclimate to temperature and humidity by placing it in the measuring test environment for 5 minutes.

Then, while holding the R-BAT away from the blade or any other magnetic material - switch the power to “on” and press the function button for approximately 3 seconds until the word “cAL” flashes on the display panel.

Remove the calibration key from the case and insert it into the calibration slot located on top of the R-BAT.



Press and release the function button once and wait for the word “good” to appear on the display panel.

It may take the R-BAT up to 3 minutes to calibrate. If the unit fails to calibrate, the R-Bat will display redo. If this happens, remove the calibration key, press and hold down the function button for 3 seconds, and redo the calibration.

1.3. RBAT Measurement Pre-Inspection

Before a measurement is taken, conduct a visual inspection of the blade to determine if any abnormalities are present. Also, inspect the R-Bat duckbill, making sure that it is free of dust and debris. This could interfere with the accuracy of a measurement.

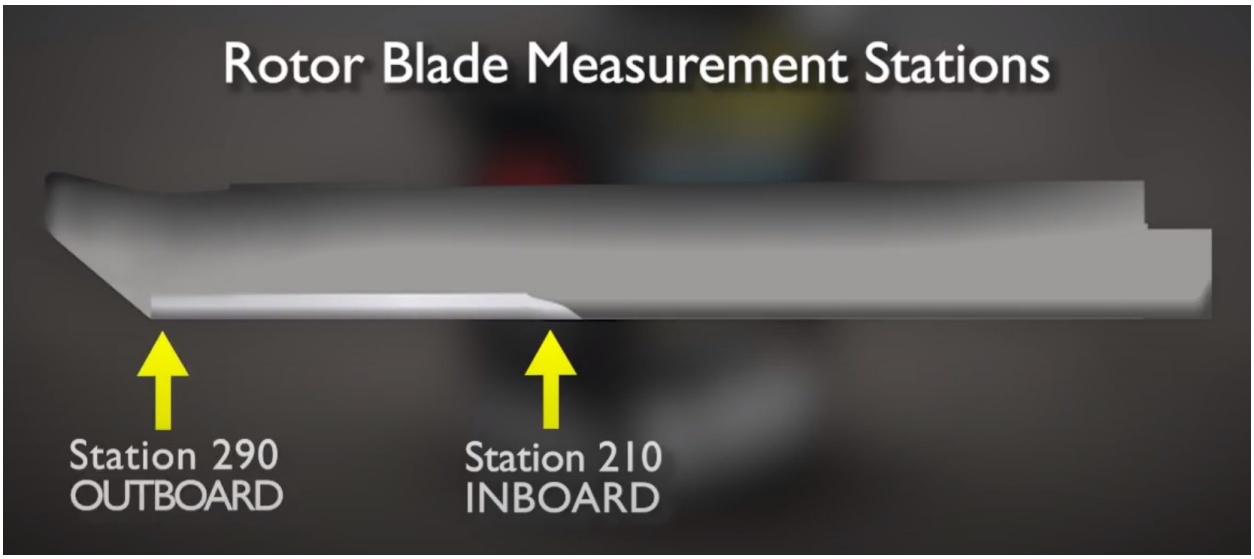
Due to the differences in initial erosion strip thickness and erosion rates along the length of the protective strip, the R-BAT has been configured to provide different nickel thicknesses ratings based on the measurement location.

If a taco patch is covering the nickel strip surface, a measurement cannot be made. A painted strip surface may exhibit an inaccurate measurement value that is less than the actual nickel strip thickness. Users should measure the strip before repainting the rotor blade if possible.

1.4. Taking an R-BAT Measurement

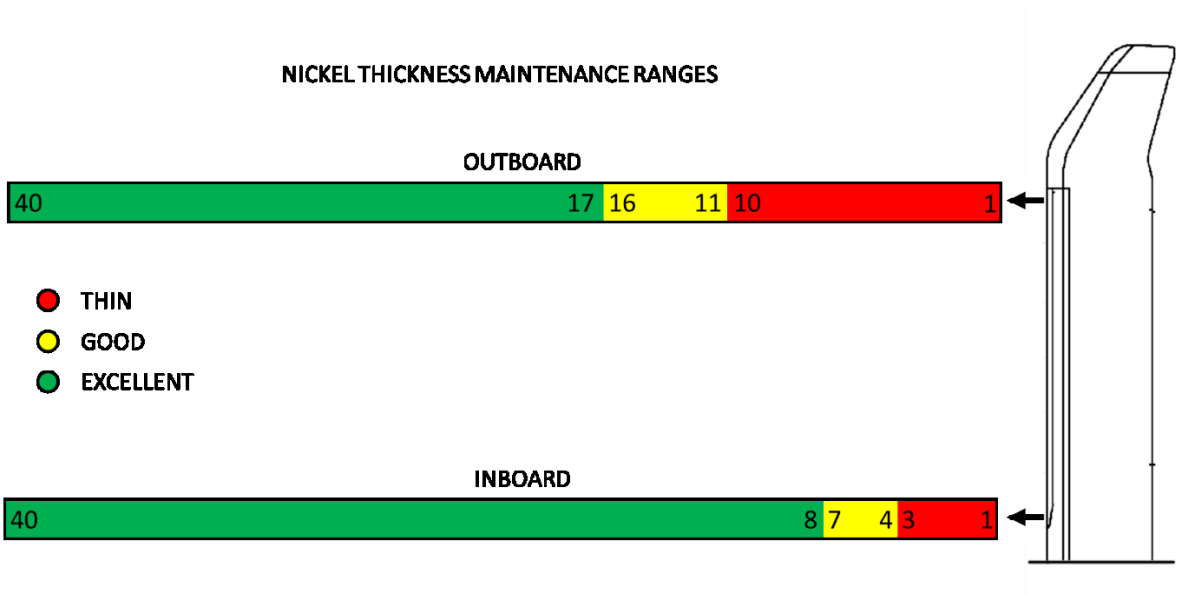
To configure the RBAT for the location to be measured, hold the R-BAT unit away from the rotor blade or any other magnetic material, press and release the function button once. This prepares the R-BAT for an outboard (station 290) measurement and shows “-ob-” on the display. The unit is now ready to take an outboard measurement. For an inboard measurement, press and release the function button twice. “-ib-” will appear on the display indicating the R-BAT is ready for an inboard (station 210) measurement. During these processes, the R-BAT unit also zeros itself for use.

To take a measurement of the nickel strip, align the side of the R-BAT housing with the edge of the nickel strip at either station 210 for an inboard or 290 for an outboard measurement. Fit the base of the R-BAT duckbill to the base of the respective surface on the blade. Then, slide the R-BAT forward until the duckbill is flush with the blade's nickel strip. Press and release the function button to begin the measurement. A solid "o-b" or "i-b" will appear on the display panel. During this time, do not remove the R-BAT from the blade surface. The measurement process takes approximately 3 seconds and will display the measurement in mils (1 mill = 0.001") when completed.



[picture of taking a measurement]

The R-BAT will provide a thickness in mils on the display and illuminate one of the three LEDs. If the nickel measures above 7 for inboard or above 16 for outboard, the nickel strip is in "excellent" condition and a green LED will illuminate in this condition. If the nickel thickness is within 7 to 4 for inboard or 16 to 11 for outboard, the nickel strip is in "good" condition and a yellow LED will illuminate. If a thickness is below 4 for inboard and below 11 for outboard, the nickel strip is thin and needs replacement and a red LED will illuminate.



If “redo” is displayed on the panel, this indicates that the measurement lies outside the expected range of 1 to 40 mil and should be measured again. When “redo” is displayed the unit will also illuminate an LED indicating whether the measurement was below 1 (red) or greater than 40 mils (green).

To execute another measurement, remove the R-BAT from the blade surface. Then press and release the function button once for outboard or twice for inboard measurement. This clears the previous measurement, tares the R-BAT and identifies the next measurement location.

1.5. Sleep Mode

If the R-BAT is inactive for more than 30 seconds, the digital display panel will go blank with a blinking LED indicating the battery’s state of charge.

2. R-BAT Plus System Kit

The Rotor Blade Analysis Tool – Plus System -"R-BAT-PLUS"- provides an accurate indication of the strip's condition, giving aircraft technicians the ability to easily measure rotor blades during maintenance or pre-flight inspections. Combining the supplied Controller with the R-BAT unit, allows users to conduct measurements with a touch pad. The measurement surveys are coded and stored on an SD Card for future inspection and research analysis. Based on the thickness measurements of the erosion strips, decisions can then be made as to whether the blade is ready for fielding or should be further serviced before continued use.

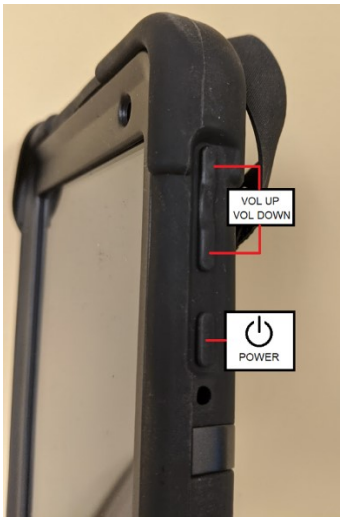
The R-BAT Plus system kit is delivered in a durable padded case with compartments for each component. It contains the R-BAT measurement device, a calibration key, a charging cable and power adapter, a lanyard, and a quick reference guide. Additionally, the kit includes an R-BAT controller which allows users to conduct measurement operations from the touch pad, as well as retain measurement data for future reference.

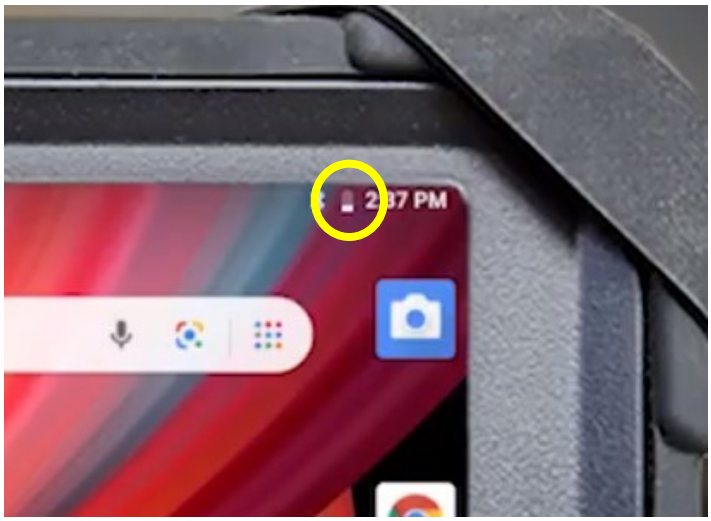
The R-BAT controller is equipped with a power button, charging port, Otterbox hand strap, and a tablet lanyard.

When using the controller, the R-BAT tool is charged and calibrated through the same measurement preparation process as shown in the R-BAT System Kit section. (See the respective paragraphs in the R-BAT section)

2.1. R-BAT Controller Charging and Setup

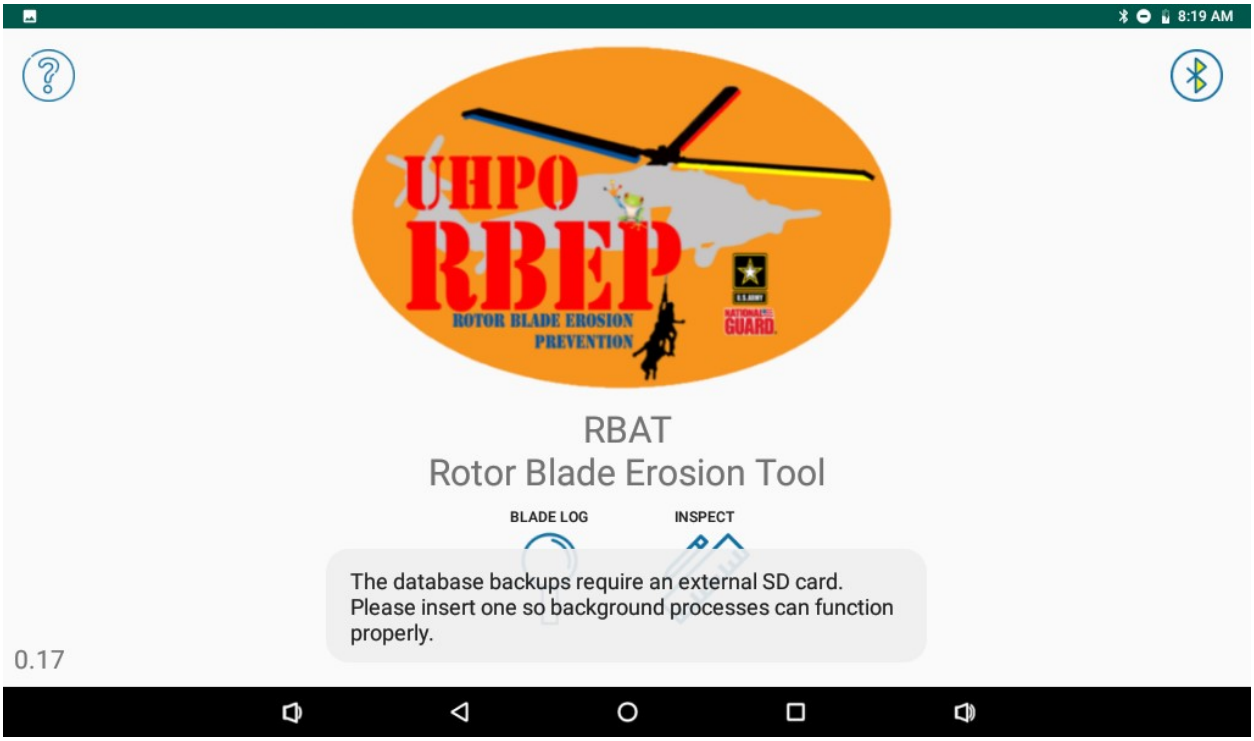
To use the R-BAT controller during the measurement process, turn the tablet on using power switch. This will bring up the tablet home page which lists the battery state of charge as a battery icon in the upper right hand corner.





If the state of charge low or the tablet does not turn on, charge it using the supplied USB charger. The micro USB charging port on the tablet can be found on edge of the device as shown. It can take up to 3 hours to charge.

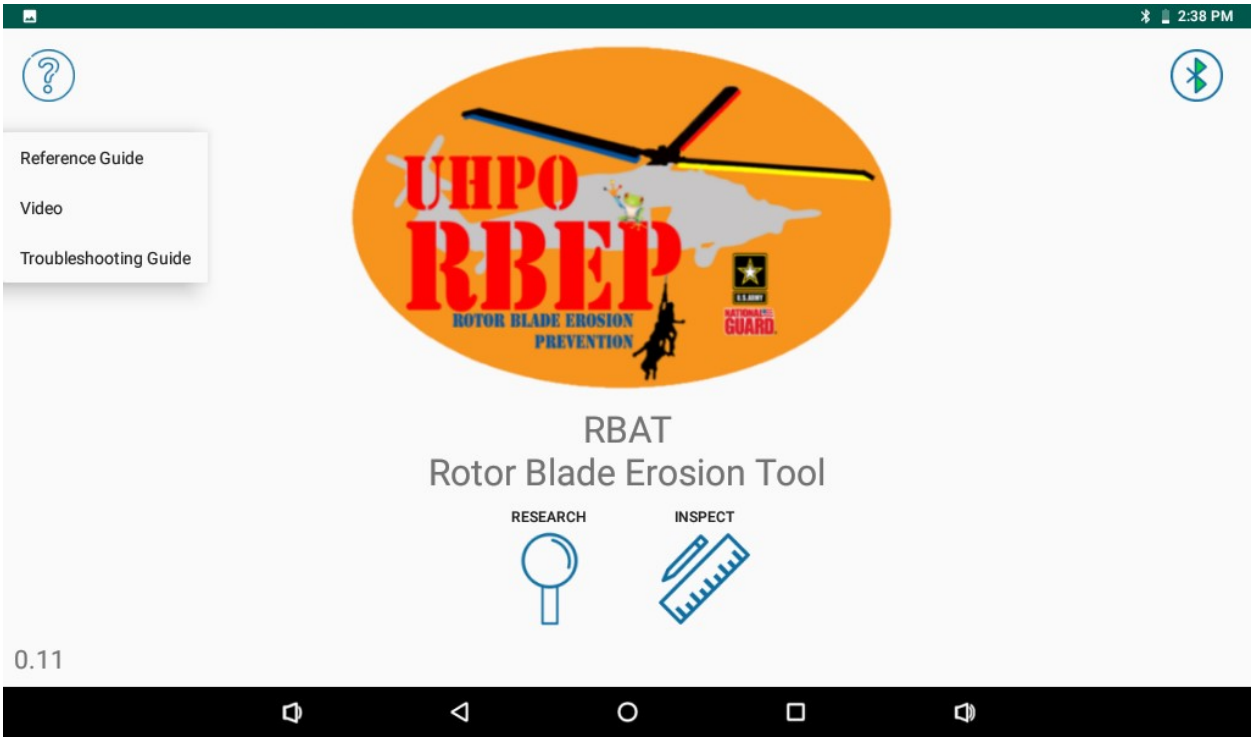
Once charged, ensure that a UPT supplied SD card is installed in the controller and turn on the controller by pressing the power button. Next, select the R-BAT app on the touch pad. This launches the app and leads to the RBAT homepage. If an SD card is not installed, the app will display the notification below indicating that a SD card must be installed for the app to function properly.



If this is the first time the SD card is being used, direct the system to store data in the RBAT directory on SD card. (See Transferring Data from the R-BAT Controller)

2.2. Home Screen

The home screen contains icons for Blade Log, Inspection, and help, as well as a Bluetooth symbol indicating communication with the R-Bat unit. A green Bluetooth symbol indicates that communication with the R-BAT unit is connected. If the Bluetooth symbol is red, cycle the R-BAT unit power until the symbol turns to green, or enter the tablet settings to ensure that Bluetooth communication is turned on. If selected, the help icon provides access to a reference guide, instructional video and troubleshooting guide. These are also available from the RBEPteam.org website and can be accessed through the QR code below using a smartphone.



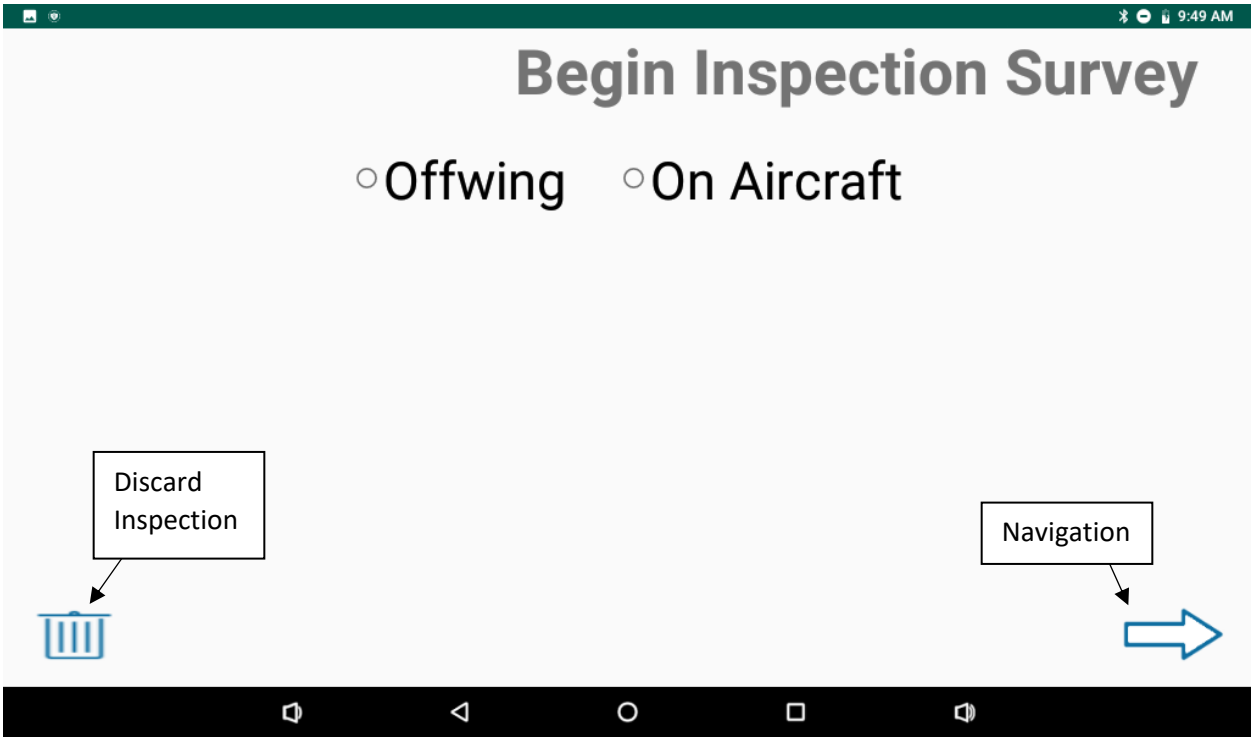
In environments where Bluetooth connection is not allowed or available, the measurements from the R-BAT unit may be manually entered and saved on the Controller. This will allow users to access previous inspections and research at a later date regardless of connectivity with the R-BAT.

2.3. R-BAT Controller Inspection

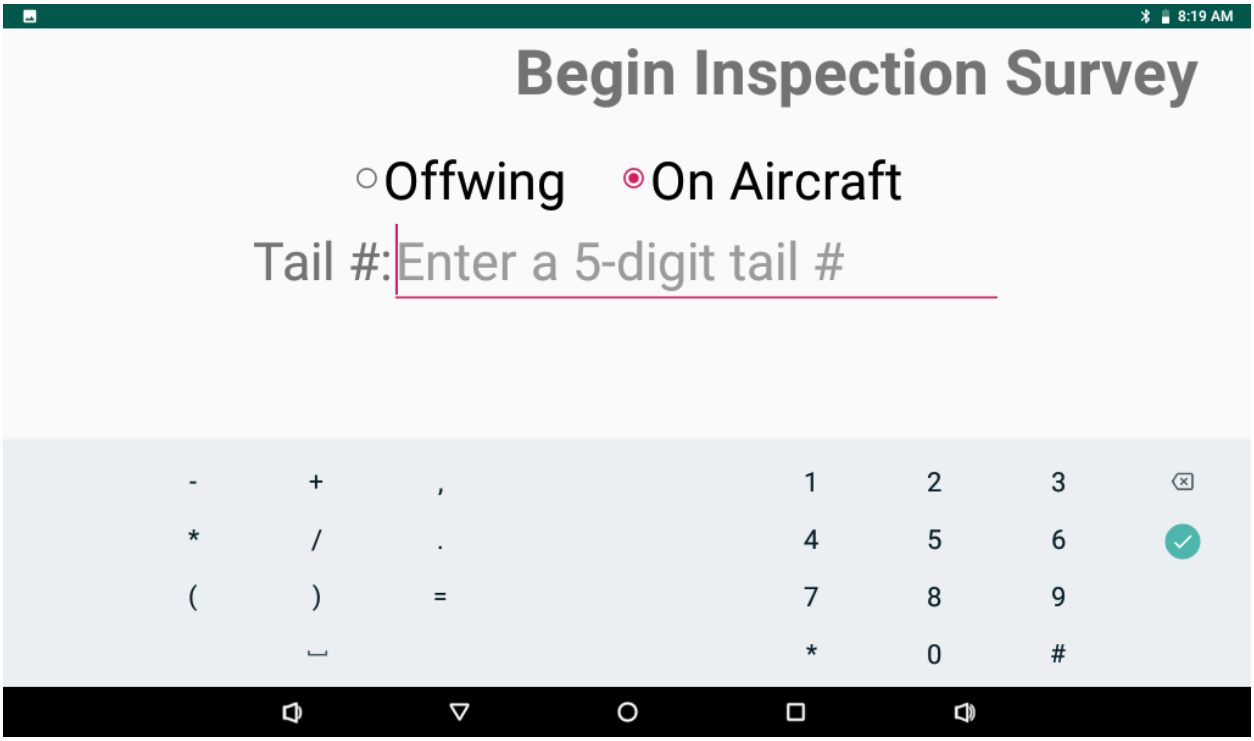
To prepare for nickel thickness measurements, from the home screen, select “Inspection” on the controller touch pad.

2.3.1. R-BAT Controller Begin Inspection Survey

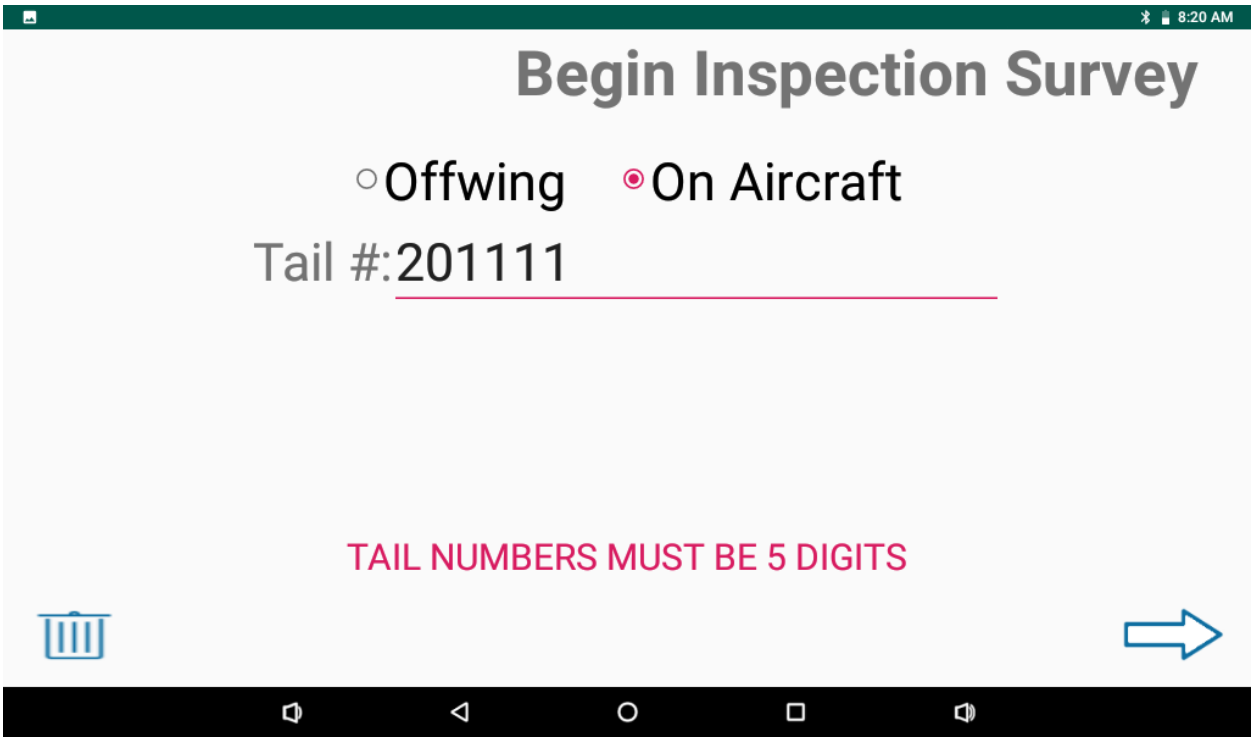
Each page of the inspection survey contains arrows for navigating forward or backward, and a trash icon. The trash icon stops the inspection and discards the recorded data of the inspection. It also directs the controller back to the home page.



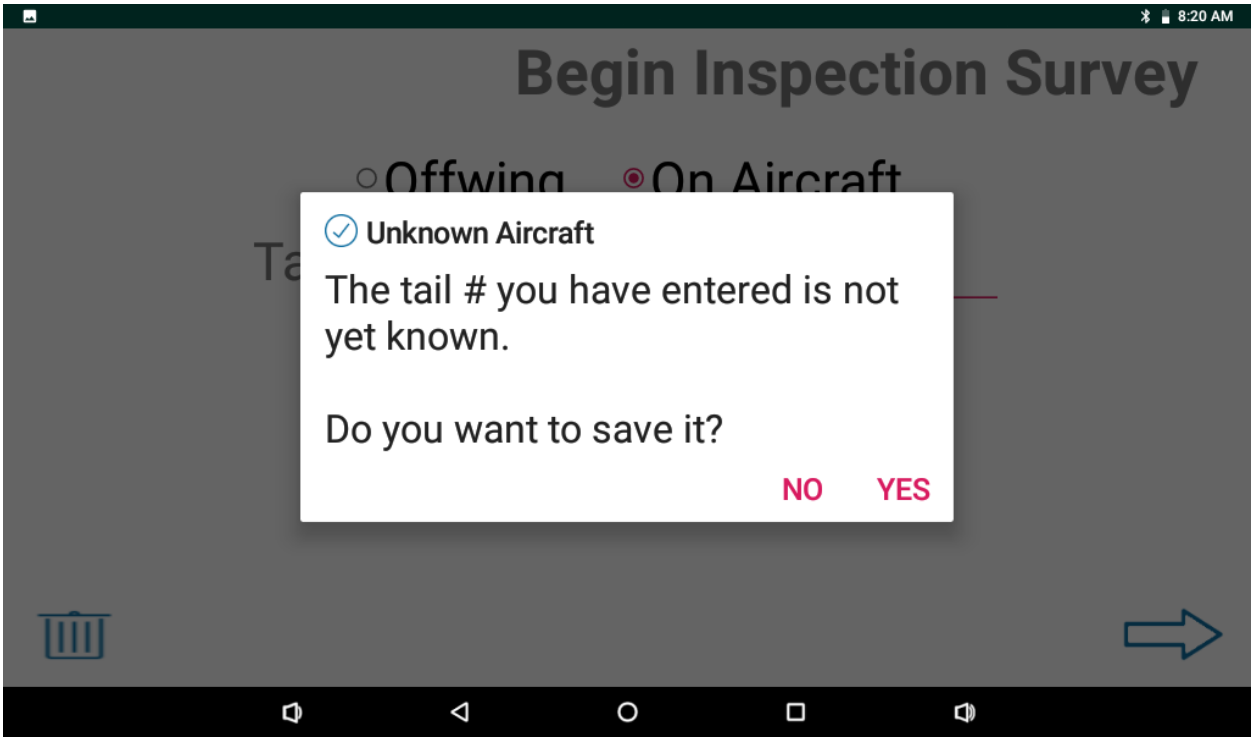
On the inspection screen, select whether the inspection is being performed “off-wing” or on the aircraft. No tail number is required to continue the inspection if “offwing” is selected. If the inspection is being done on-aircraft, type in the aircraft tail number using the controller keypad. A dropdown list of previously identified aircraft may appear to help with the selection process.



Only 5-digit aircraft numbers will be accepted. If the user attempts to proceed with an on aircraft inspection without a 5-digit tail number a warning display on the controller.



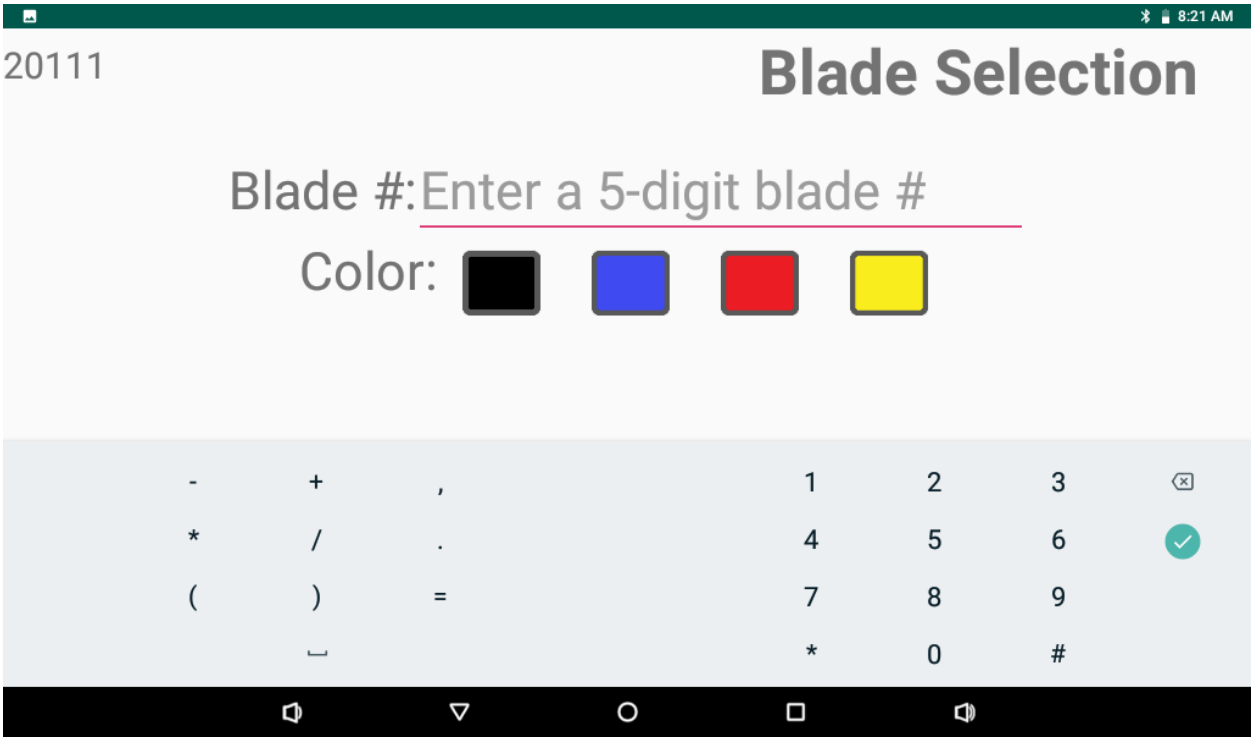
When the 5-digit aircraft number is entered and the user attempts to continue with the inspection, the app will indicate an option to save the aircraft number for future selection if this tail number has not been saved previously. This will allow future selection of saved aircraft from a dropdown menu list.



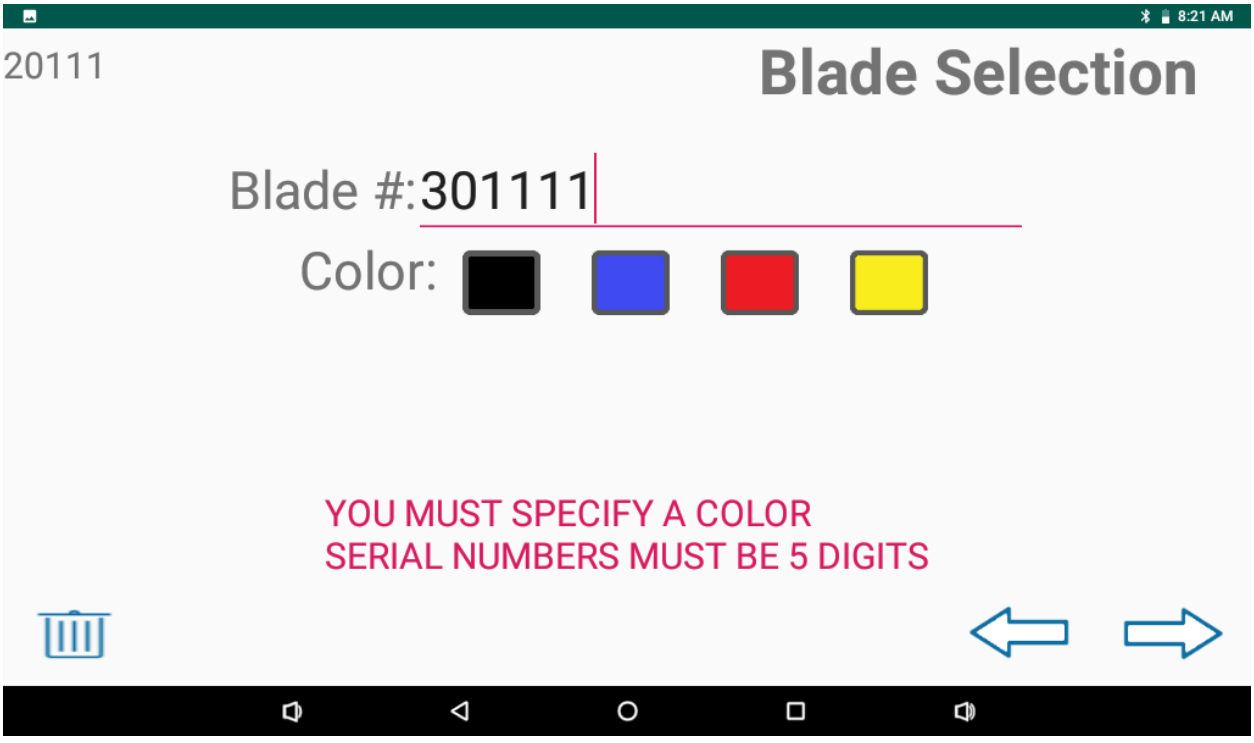
Press the forward arrow to proceed to the specific blade selection page.

2.3.2. Blade Selection Page

On the blade selection page, verify that the aircraft tail number, or “off-wing” entered on the previous page is listed in the upper left corner of the page. Next, enter the 5-digit blade serial number using the keypad– followed by the blade position color, or select from a dropdown list of saved blades.



Again, only 5-digit blade serial numbers will be accepted. Any number other than 5 digits will activate a warning display on the controller when the user attempts to navigate to the next screen. A warning will also be displayed if no blade position color is selected for on aircraft blades. Color options are not provided for off-wing blades.

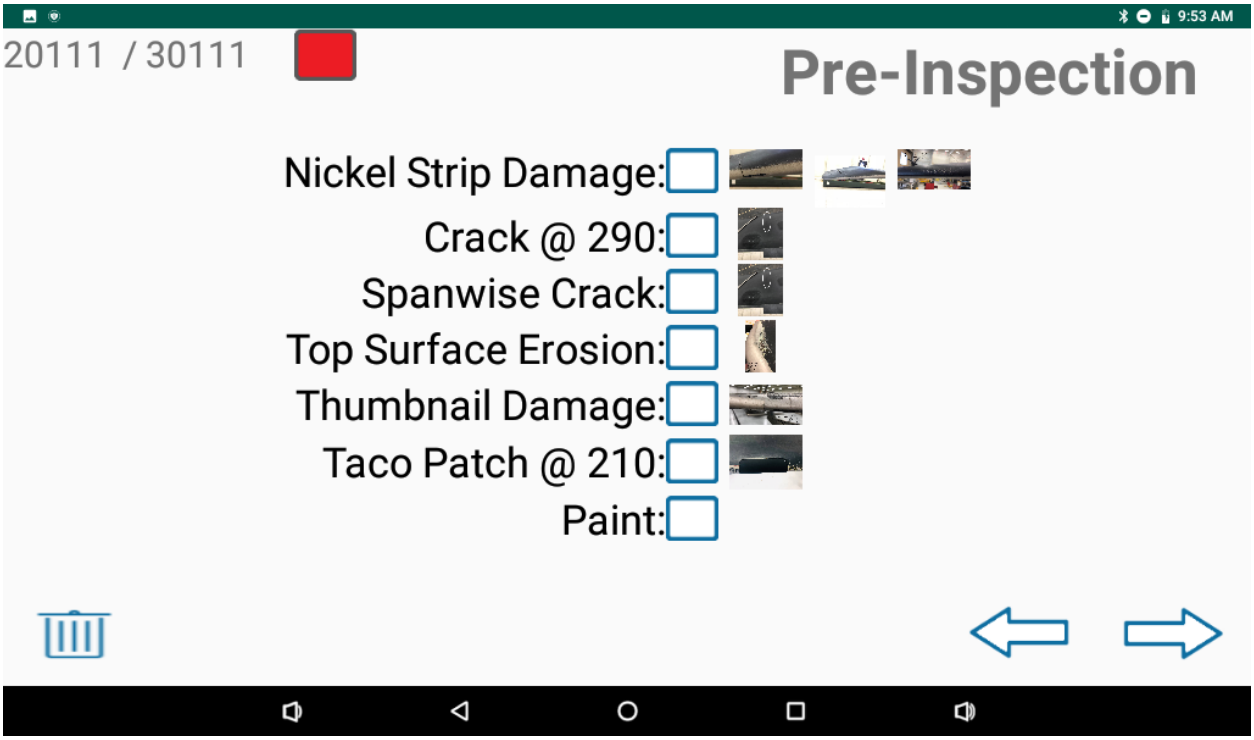


When the 5-digit blade serial number and blade color are accepted, the app will indicate an option to also save the blade number for future selection. This again will allow future selection of saved blade numbers from a dropdown menu list.

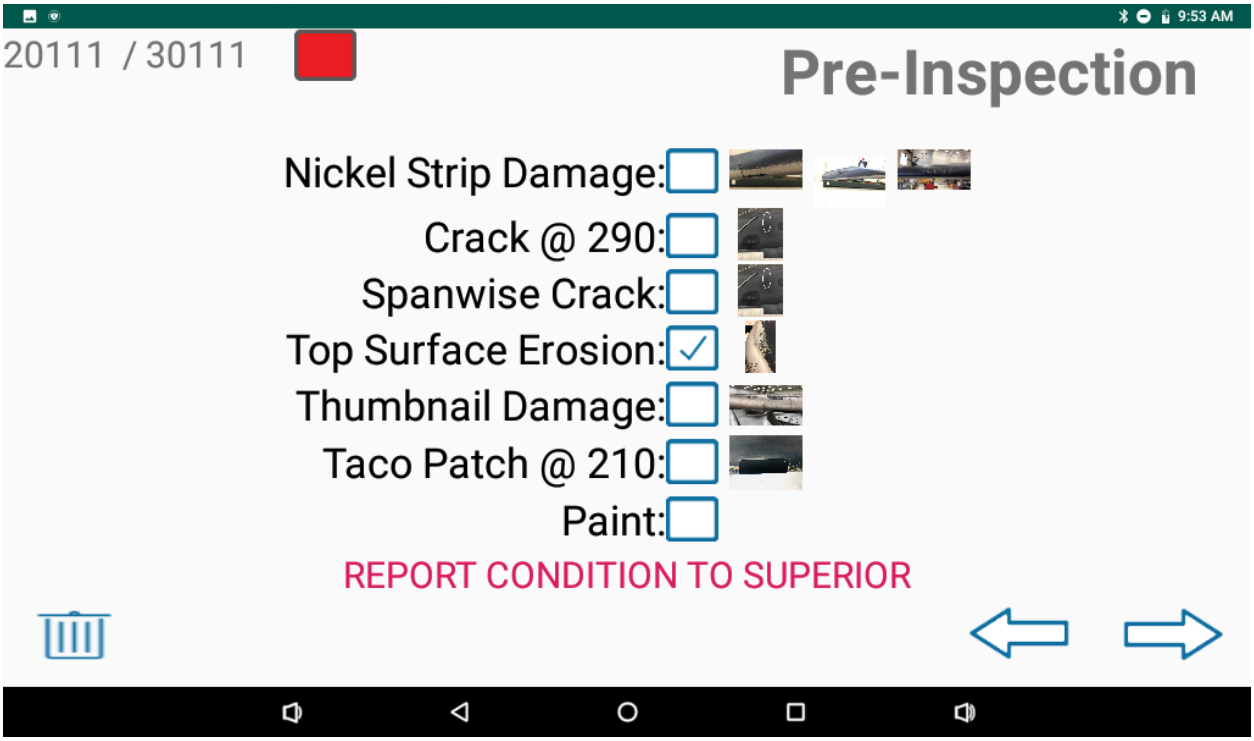
Next, press the forward arrow to continue to the pre-inspection page, or select the back arrow to re-enter aircraft or blade serial numbers.

2.3.3. R-BAT Controller Blade Pre-Inspection

The pre-inspection page lists the entered 5-digit aircraft tail number (this is replaced by [offwing] if conducting offwing inspection), blade serial number, and color in the upper left corner of page.



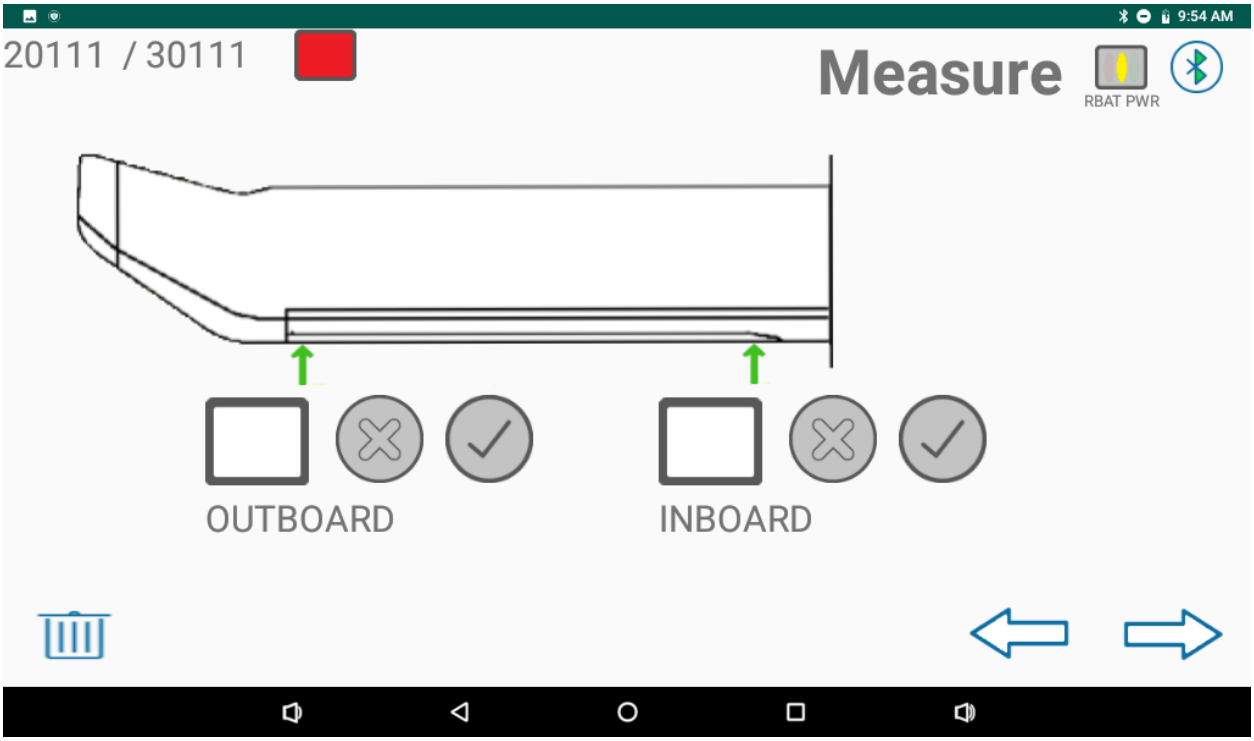
Here, there are option boxes to select observable blade damage after a visual inspection. Sample reference pictures of each type of damage are visible on the side of the screen. If necessary, select a picture for more detail. If any damage is selected, a “Report Damage to Superior” notification will flash, indicating that additional examination of the blade is required to ensure safety. Note that selecting “Taco Patch @ 210”, or “Paint” will not show this warning as these are not considered damage.



Next, select the forward arrow to advance to the R-BAT measurement page, or back to return to the blade selection page.

2.3.4. R-BAT Controller Measurement Page

On the Measurement page, the aircraft tail number ([offwing] if conducting offwing inspection), blade serial number, and color are again listed in the upper left corner. The page also lists displays the current R-BAT battery state of charge (RBAT PWR) and a Bluetooth symbol indicating communication with the RBAT in the upper right-hand corner of the page. There are also locations for inboard and outboard measurements.



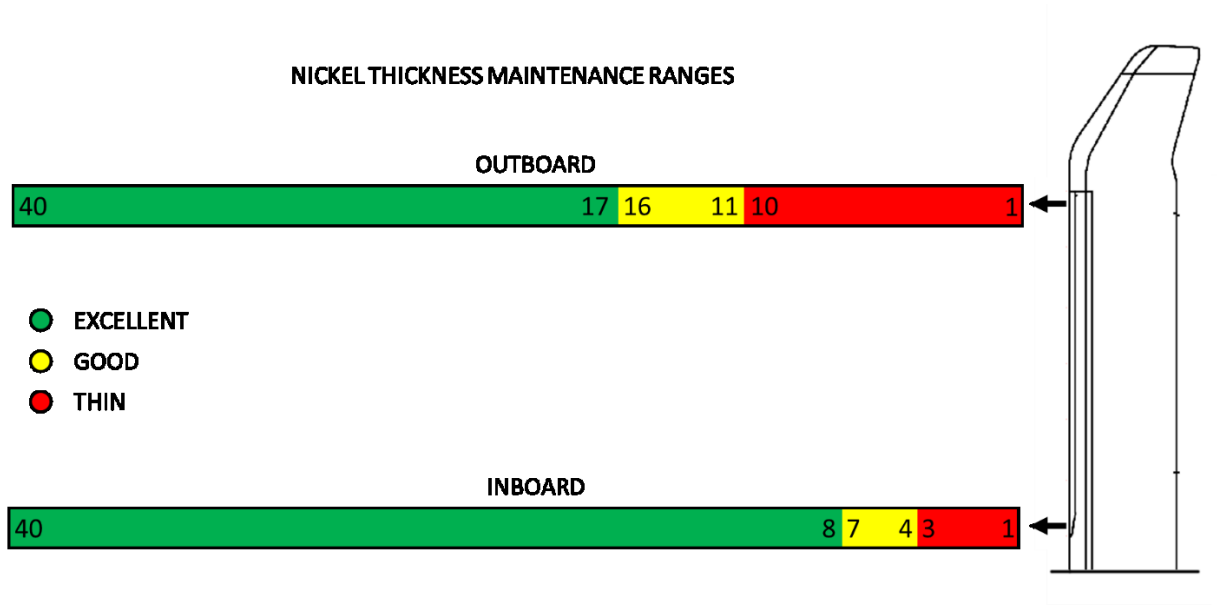
To take an “outboard” measurement of the nickel strip thickness:

1. Ensure that the R-BAT unit is away from any magnetic material and clean of any foreign objects.
2. Select the outboard measurement box on the R-BAT controller.
3. Align the side of the RBAT tool with the outside edge of the nickel strip and fit the base of the R-BAT duckbill to the base surface on the blade.
4. Slide the R-BAT tool forward until the duckbill is flush with the blade on the outboard location of the nickel strip.
5. While holding the R-BAT securely in this position, press and release the function button to take a measurement.
6. Hold the R-Bat in this position until the measurement appears on the controller’s corresponding measurement box. The measurement box will also be filled with a color corresponding to the rating of the measurement.
7. Select the check mark to accept the measurement, or X mark to reject the measurement.

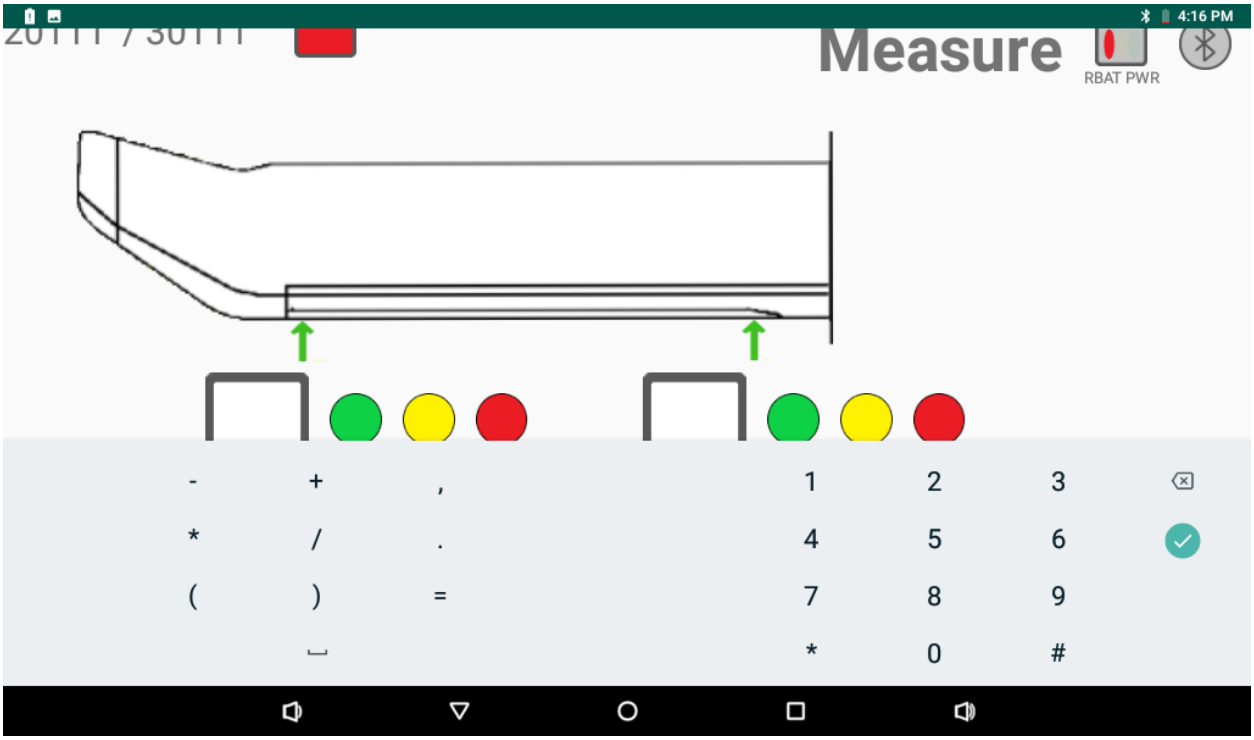
If the measurement is rejected, remove the R-BAT unit from blade and then reselect the measurement box on the controller. Next, refit the R-BAT to the blade using the same process above to remeasure the nickel strip location.

To take an “inboard” measurement of the nickel strip thickness, select the inboard measurement box on the controller pad and repeat the process with the R-BAT aligned to the inboard edge of the nickel strip. It is important to note that the inboard location will not be available if “taco patch at 210” was selected during the pre-inspection.

The rating scale for each measurement location is listed below. The measurements are listed in mils (1 mil = 0.001”)



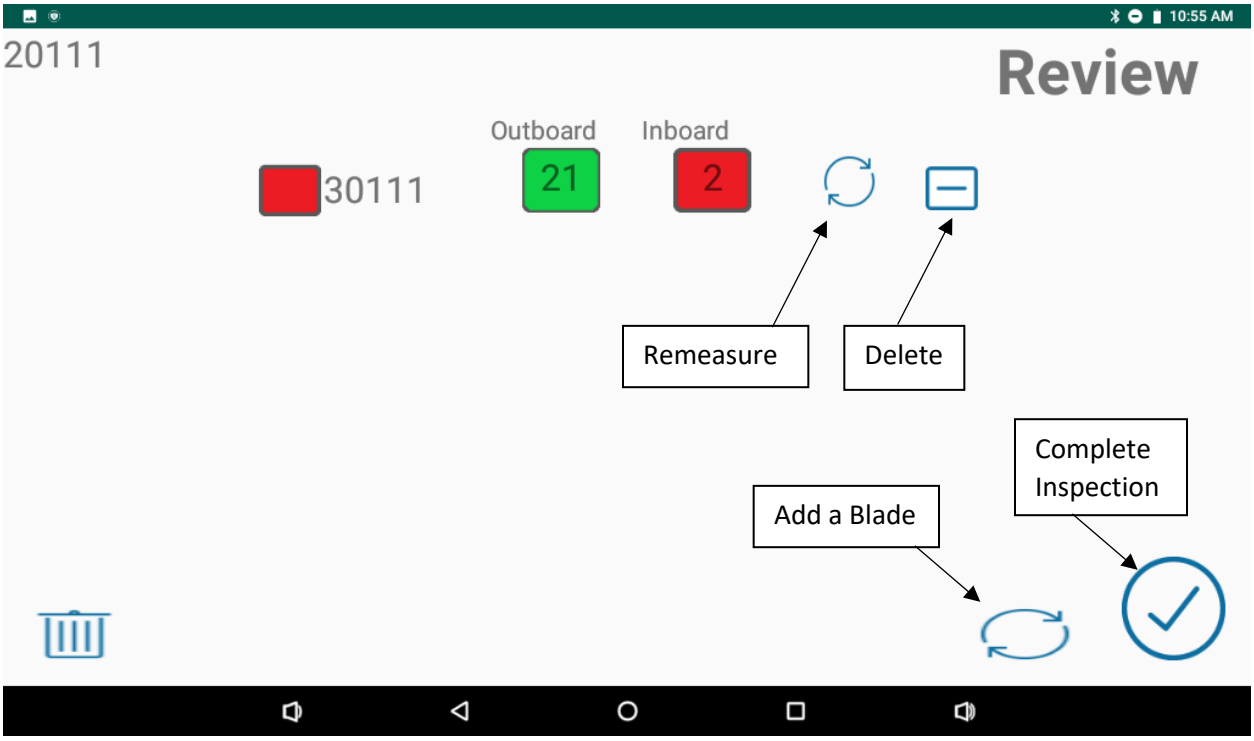
If Bluetooth communication cannot be established, the software allows for manual input of the R-BAT measurements and their LED ranking. In this case, use the RBAT tool to measure inboard and outboard locations of the nickel strip noting both measurement and rating color for each. Input this information manually on the measure page as shown below.



Select the forward arrow to proceed to the review page, or the back arrow to return to the measurement page.

2.3.5. R-BAT Controller Measurement Review

The measurement review page shows the aircraft tail number (or [offwing]) in the upper left corner of the page and lists the blades measured on the aircraft during this inspection. The position color, blade serial number, inboard and outboard measurements are also listed on the measurement review page along with their associated color code for erosion severity. The colors align with R-BAT LED ratings for each measurement.



To remeasure inboard and outboard locations on a blade, press the circle located at the right of the blade. This will return to the pre-inspection page for that blade and allow replacement of the previous measurements of that blade.

To delete the previous inboard and outboard inspection measurements, press the negative icon located beside each respective measurement.

To measure another blade on the same aircraft, press the “oval” indicator on the bottom right. This returns to the blade selection page to add a new blade to the survey. On this page, blades which have already been measured as part of the survey are grayed out and cannot be selected. If all 4 blades have been measured on an aircraft, the oval indicator will not appear. A maximum of 4 wings may be measured while measuring on-aircraft.

If off-wing inspection measurements are being taken, the oval option will remain regardless of the number of blade inspections.

Once blades have been measured, press the check mark on the controller. This brings up a notification asking if the survey is complete. Pressing “yes” collects all measurements from the review screen into a single survey and saves it to the SD card. It then directs the user back to the controller’s home page.

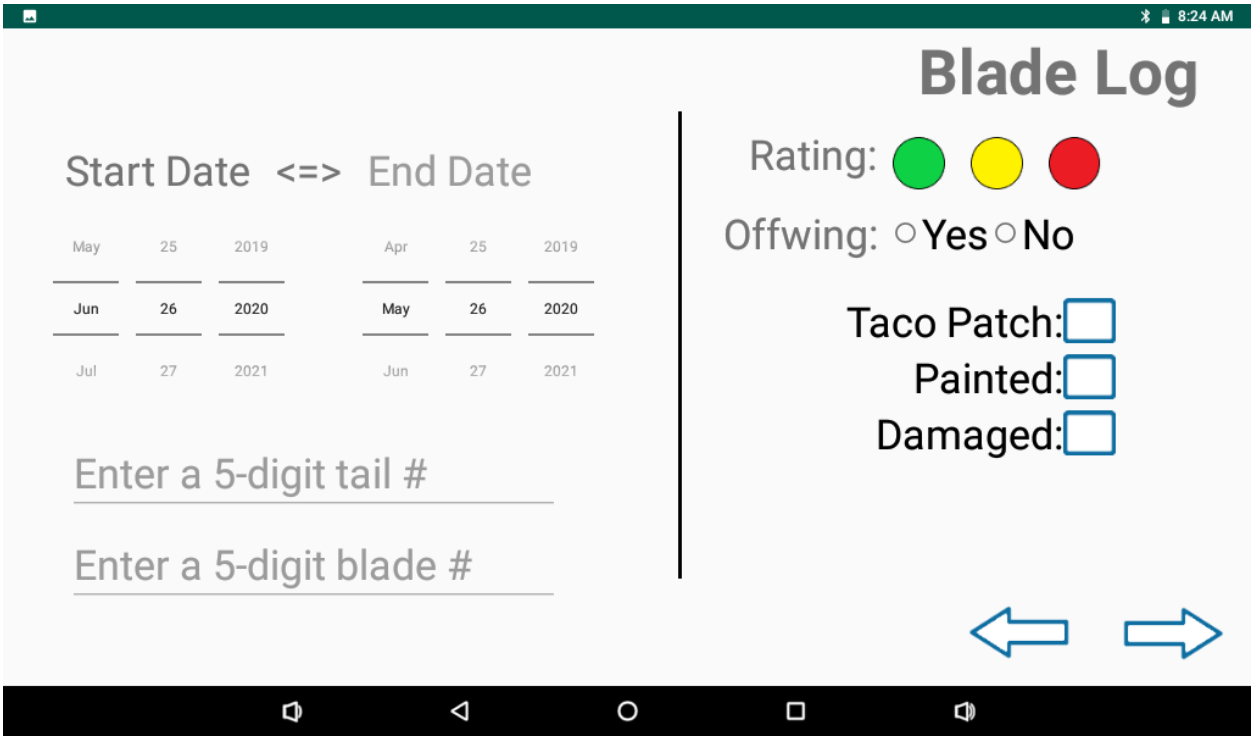
If the check mark is not selected, the data will not be saved.

2.4. R-BAT Controller Blade Log

The controller's Blade Log allows the user to view previous blade measurements.

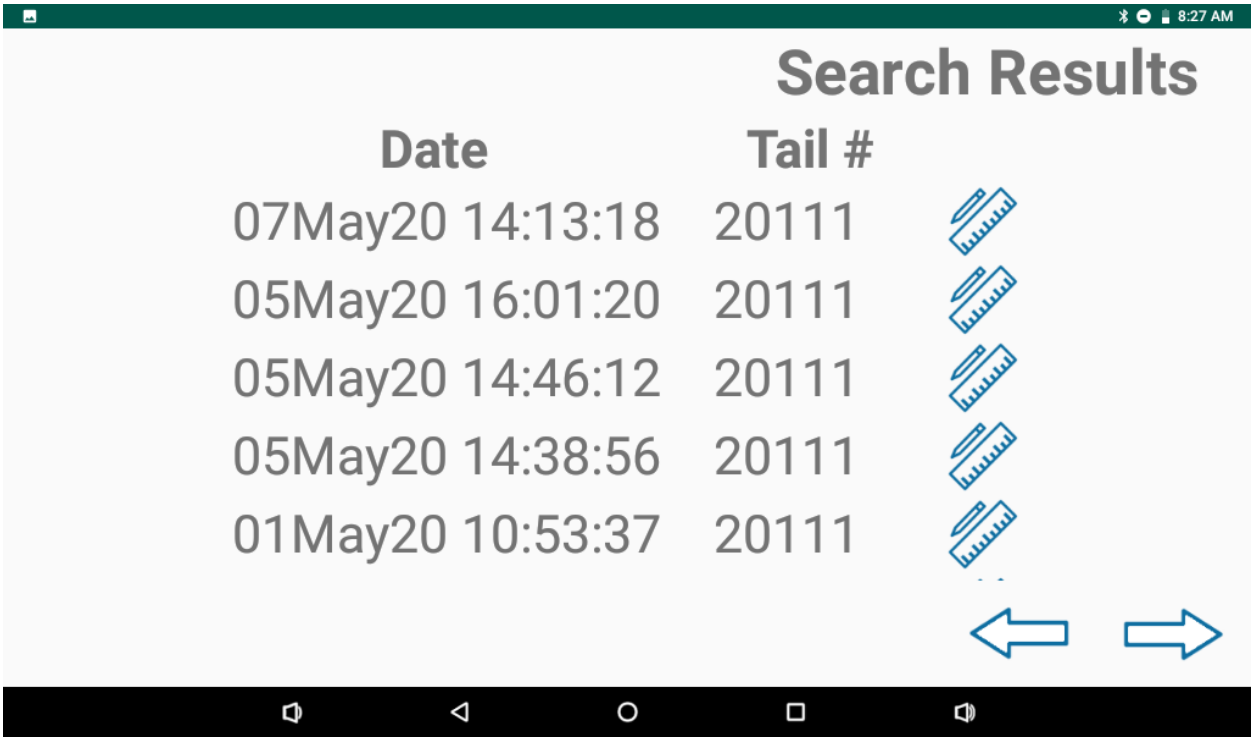
2.4.1. R-BAT Controller Blade Log Search

To access the controller's Blade Log page, select "Blade Log" from the home screen. This page allows the user to search blade measurement history by date, tail number, blade number, blade rating, blade location, taco patch, paint, or reported damage. Any of these identifying factors can be selected at the same time to narrow the search further. Once the search range has been selected, press the forward arrow to continue to the "Search Results" page, or the back arrow to return to the Home Screen.



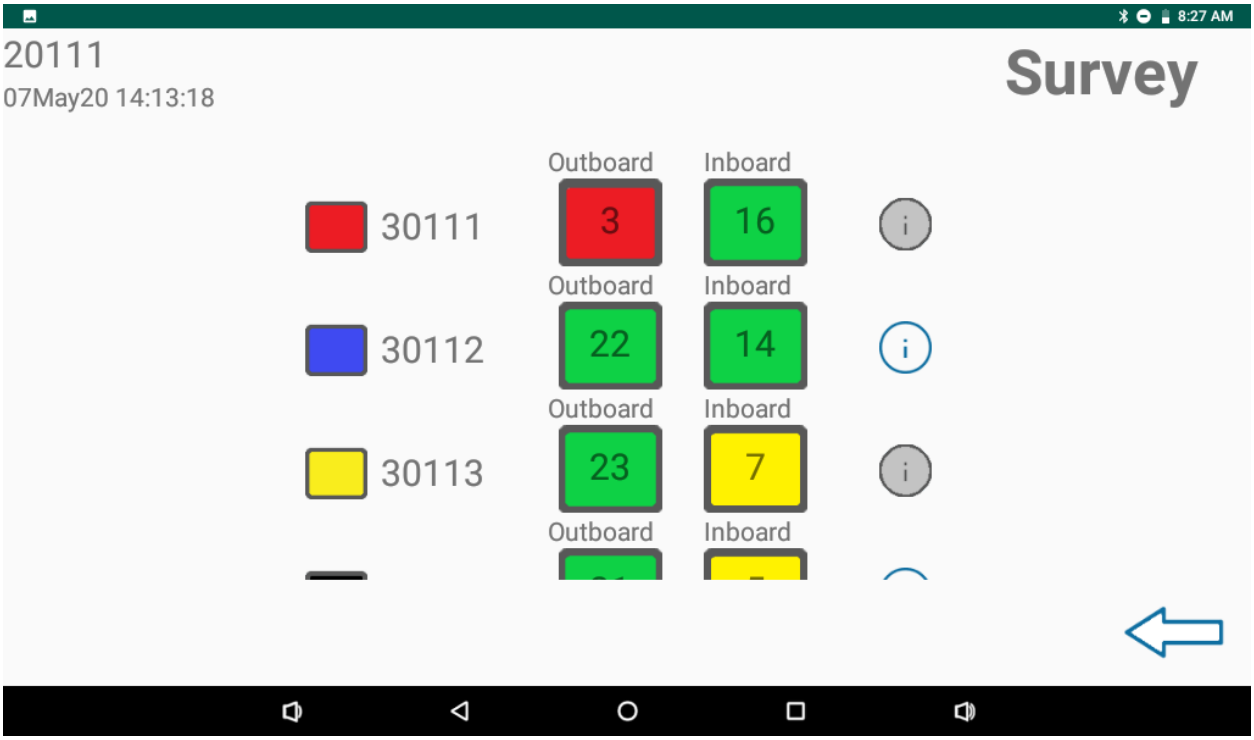
2.4.2. Blade Log Search Results

The Search Results page lists the surveys covered within the selected time frame from the previous page. Each survey is identified with a date and time stamp, as well as the aircraft tail number if available.



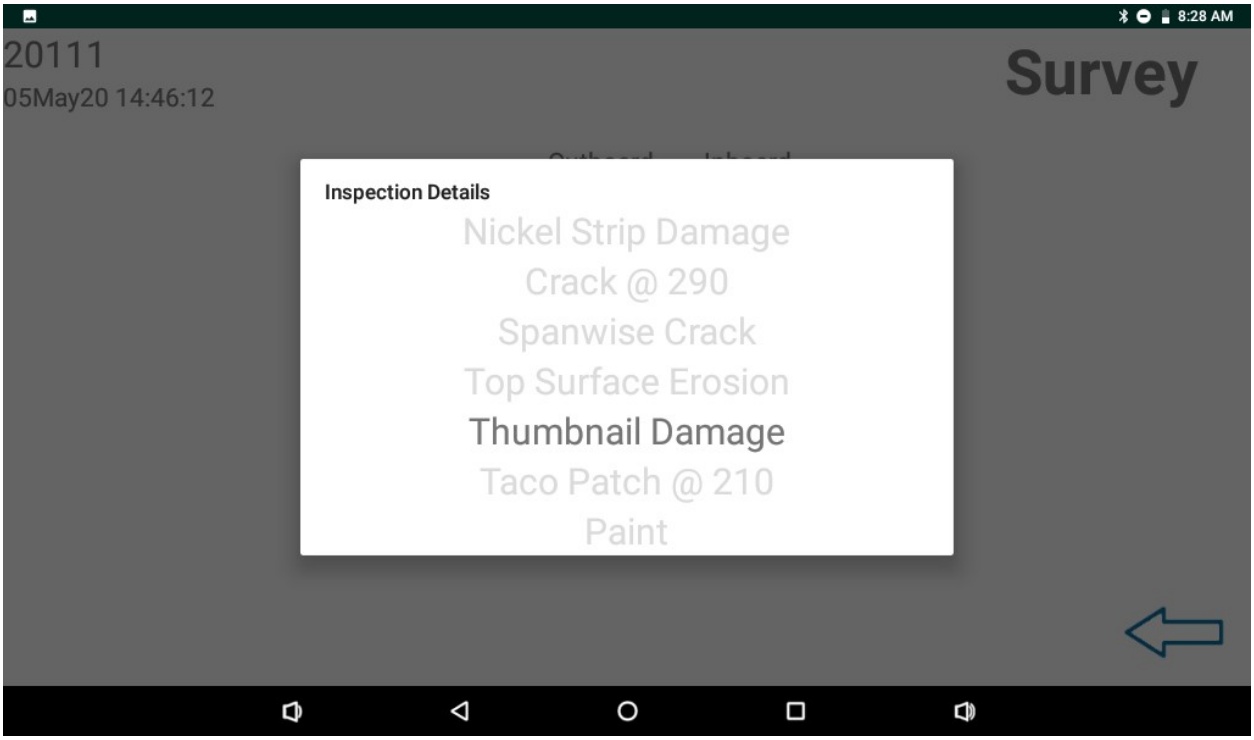
2.4.3. Blade Log Survey

Selecting the ruler located to the right of each tail number directs the user to the survey page where the aircraft tail number is listed, along with all blade measurements taken during the survey.



2.4.4. Survey Inspection Details

If a blade was recorded as having damage, a taco patch, or paint, more detailed information is available by pressing the “I” next to the blade in question. This displays a list of the issues that were recorded for the blade.



Select the back arrow to return to the Search Results page.

2.5. Transferring Data from the R-BAT Controller

All blade log data is stored on the controller SD card. If data transfer is desired, an alternate SD card supplied by UPT may be used.

2.5.1. Accessing SD Card

To access the SD Card slot, first remove the hand strap.

Next, remove the rubber outer protective cover.

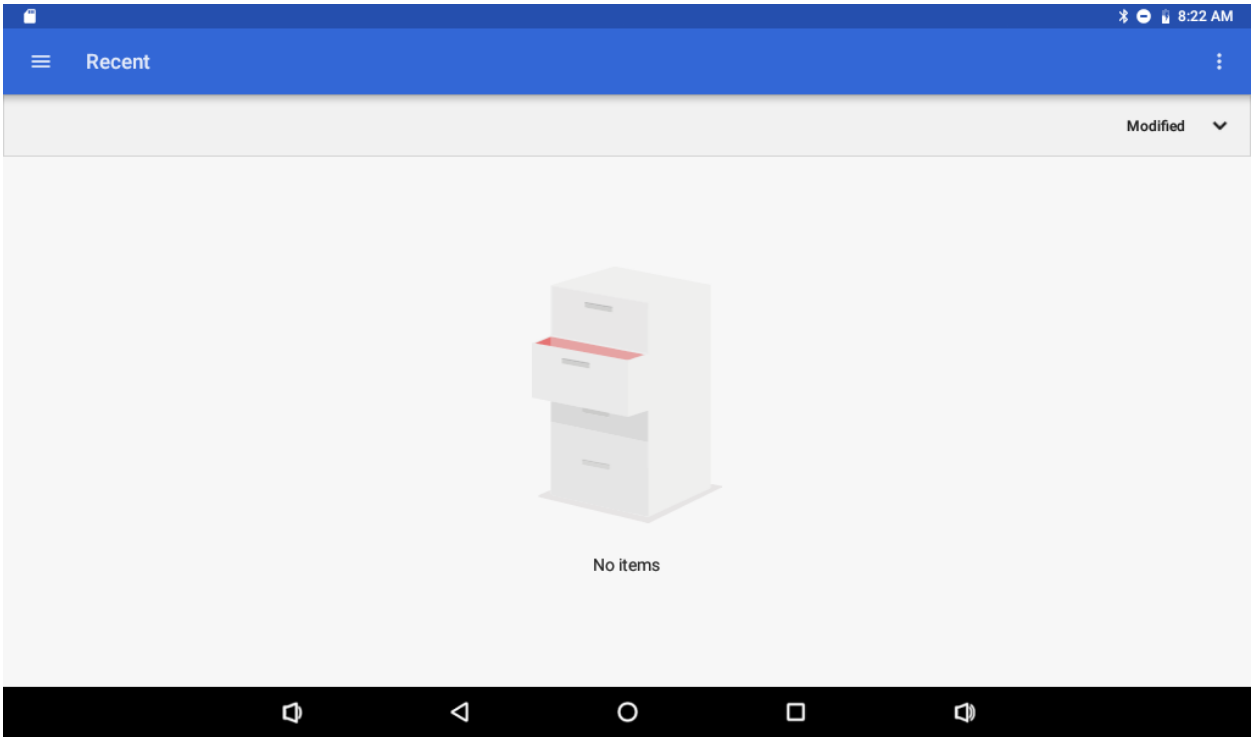
Then remove the controller's plastic outer casing by releasing the plastic case clips on each side of the controller. This can be done with a fingernail.

This allows access to the SD card slot which is located near the power port. Depress the SD card down into the slot to release the card.

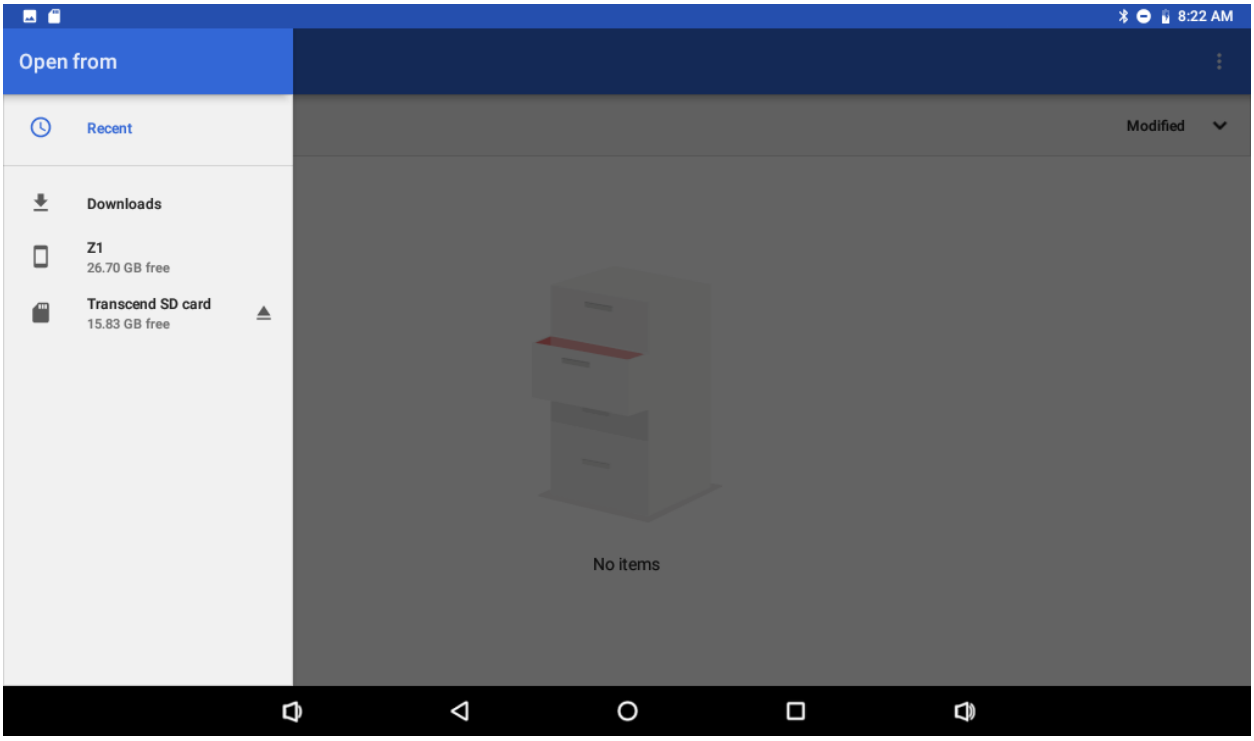
Reverse these directions to reassemble the RBAT controller when the SD card is replaced.

2.5.2. Setting the File Path

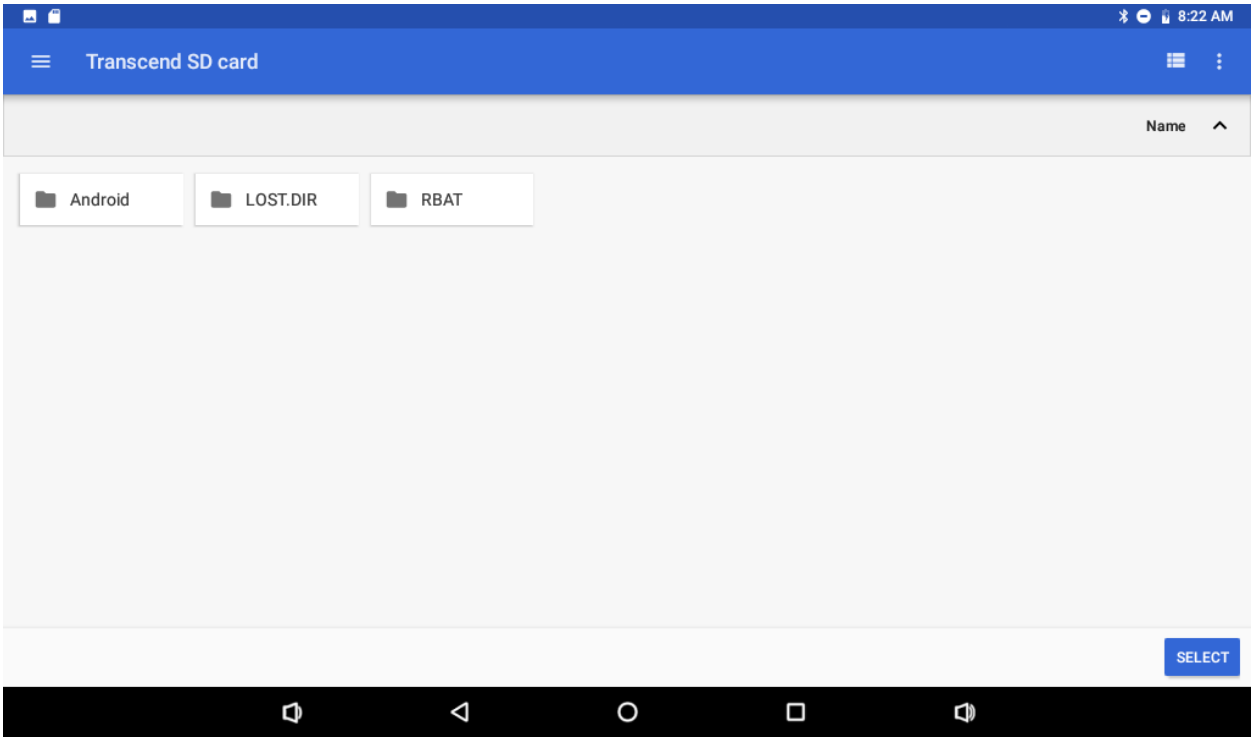
If the card has not been installed in the controller previously, the user must identify a storage location for RBAT data on the SD card. Once the user selects the app, a screen listing “No Items” will appear.



From this screen, select the three horizonal lines in the upper left-hand corner and select the SD card from the drop down menu.



In the SD card folder, select the RBAT directory and hit “SELECT” in the bottom right hand corner. This will establish the save file path for RBAT data and open the app.



If a the user wants to use an SD card not supplied by UPT, the user must create a file named RBAT on the SD card to allow for file saving. Note that preloaded help options will not be available in this case.

3. Troubleshooting

Issue	Resolution
R-BAT unit fails to charge	Check all connections on the USB charger, and especially the connection at the R-BAT's micro USB port. If the issue is not resolved, send the R-BAT unit and supplied USB charger in for repair. Also, send in the R-BAT unit for repair if the panel screen, function button, LEDs, or Bluetooth fail to function properly.
R-BAT Controller fails to charge	Check all connections on the USB charger, and especially the connection at the Controller's micro USB port.
R-BAT app will not load	Check to ensure an SD card is loaded. Ensure save path is established. Contact United Protective Technologies for support
Bluetooth connection fails	Ensure the R-BAT unit is turned on, and that the Controller Bluetooth communication option is turned on in the tablet settings.
Previous surveys fail to display	Ensure the data range date is correct on the research page, which is accessed through the home page of the controller. Also be sure to select the check-mark on the inspection measurement review screen when making measurements. Otherwise surveys are not saved.
Controller fails to operate, shows mechanical damage, or displays other functional issues	Contact United Protective Technologies for support

4. Warranty

UPT expects the RBAT system will be free from defects in material and workmanship for its lifetime. UPT anticipates offering a repair or replace warranty for the RBAT for up to 1 year from time of purchase. This does not cover damage from neglect, misuse, contamination, alteration, accident or abnormal conditions of operation or handling, including failures caused by use outside of the product's specifications, or normal wear and tear of mechanical components. It is expected that UPT will enter a service agreement for device assistance beyond the 1-year warranty period.

5. Routine R-BAT System Maintenance

The RBAT (Rotor Blade Analysis Tool) system is comprised of the RBAT, RBAT controller tablet and storage case. Only minor maintenance is required for the system to operate properly.

Figure 1: RBAT, RBAT controller and RBAT system carrying case

5.1. RBAT Maintenance

When fully charged, the RBAT can take over 3000 measurements without recharging. While this is the case, the RBAT must be fully charged every 6 months to ensure battery life. The system must also be kept clean to ensure accuracy. This may be completed through routine cleaning with a damp cloth prior to performing measurements. The R-BAT also must be calibrated prior to each use. This is accomplished using the calibration key included with the system. It is also important to keep the R-BAT in its carrying case as much as possible and use the enclosed wrist lanyard when making measurements to prevent damage from drop.

Required RBAT Support	Resources Needed	Action if failed
• RBAT must be calibrated before use and after a drop	• Calibration Standard included with the device	• If standard lost, UPT can provide another • Return device to manufacturer if system does not calibrate
• RBAT must be charged fully every 6 months	• 115VAC power outlet • Charging case provided with device • RBAT can also be charged using microUSB	• Return device to manufacturer if system does not charge
• Protection from drop and the elements	• Carrying case	• Additional cases available from manufacturer if lost or damaged

5.2. R-BAT Controller Maintenance

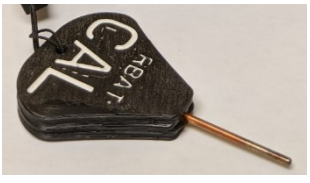
The R-BAT controller is a seven-inch tablet which includes a protective case and lanyard system. It, as well as the android-based R-BAT controller app were designed for low maintenance. Besides charging every 6 months, the tablet must be protected from drops by keeping it in its carrying case when not in use and using the included tablet lanyard system when in use.

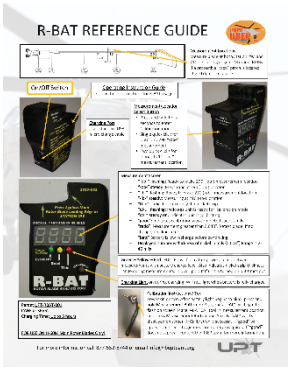
Required Tablet Support	Resources Needed	Action if failed
• Tablet must be charged	• 115VAC power outlet • Charging case provided with device • RBAT can also be charged using microUSB	• Return device to manufacturer if system does not charge
• Protection from drop and the elements	• Carrying case • Tablet strap	• Additional cases and straps available from manufacturer if lost or damaged • Additional tablets are available from manufacturer if lost or damaged

5.3. Carrying Case Maintenance

The R-BAT system is transported in a durable, foam lined polyethylene case. Other than occasional cleaning with a damp cloth, there are no maintenance requirements.

6. RBAT SYSTEM REPLACEMENT PARTS

Part Number	Part Name	Description	Part
RB001	RBAT	Rotor Blade Analysis Tool (R-BAT) standalone unit replacement	
CL002	Calibration Key	R-BAT standalone unit calibration key and lanyard replacement	

HC001	RBAT + Controller Case	Full R-BAT system protective carrying case (RBAT + Controller)	
HC002	RBAT Case	R-BAT standalone protective carrying case	
CI001	RBAT User Manual	RBAT system Instructional card Replacement	
CG001	USB Charger	Replacement Charger and cable for RBAT or RBAT Controller	
CT001	RBAT Controller	Replacement RBAT Controller tablet unit	

CT002	Controller Hardcase	RBAT Controller 3 part protective hardcase	
CT003	Controller Strap	RBAT Controller outer hand strap and lanyard	
CT004	Micro SD Card	Portable Data Storage