Civil Air Patrol, Pacific Region

TRACS v4.0

Nationwide Wide ADS-B Aircraft Tracking System for CAP Aircraft

Director of IT, Pacific Region
8-30-2021

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Introduction

TRACS v4.0 is a complete redesign of our previously successful aircraft tracking tool. The goal is to provide our Incident Commanders, Air Operations Branch directors, and any other interested parties the ability to track the aircraft they are responsible for. It helps to provide excellent situational awareness.

Data Services

We recently worked out an arrangement with FlightRadar24 to provide us an exclusive data feed for our 280+ aircraft in Pacific, Rocky Mountain, Southwest, and North Central regions. While FlightRadar24 provides the data for our CAP aircraft, we also have a great relationship with ADS-B Exchange. This company provides the ADS-B data feed for all the NON-CAP aircraft that we add to the system. We thank both organizations for providing these data feeds free of charge to us.

Supported Devices

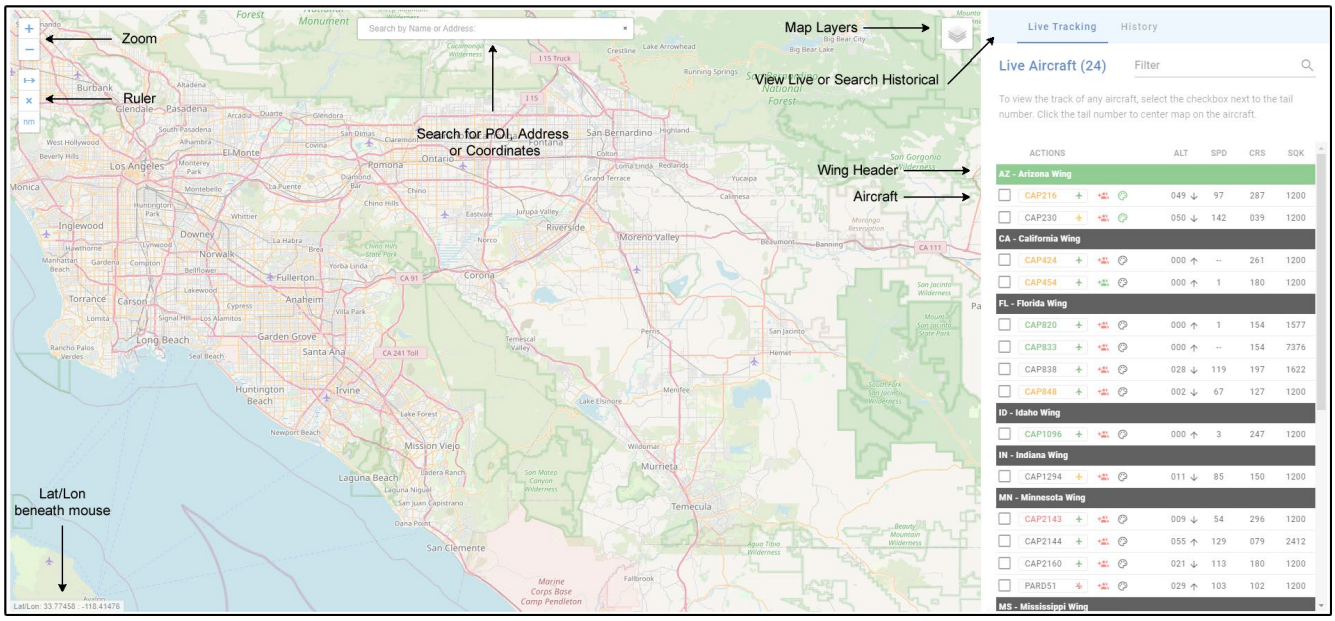
The developer made every attempt to keep TRACS mobile friendly. However, due to the amount of information being presented, mobile phones (iPhone, android, etc.) make it a little difficult to work with. You can use it, but you will be scrolling, zooming, etc. a lot. iPads, tablets, desktop computers appear to work best, due to the amount of screen that is visible.

Security / Authentication

TRACS uses Amazon Cognito to interface with Azure Active Directory Single Sign On via Security Assertion Markup Language (SAML). This means we can ensure that the login and password for TRACS is the same as your Office 365 login and password. Our design goal for all future tools will be to be based from the same mechanism to reduce the number of usernames/passwords the members must keep track of.

Main Layout

Below you will find a screenshot of the basic layout of the tool. There are many components of the main layout and we will attempt to explain each component and its purpose.

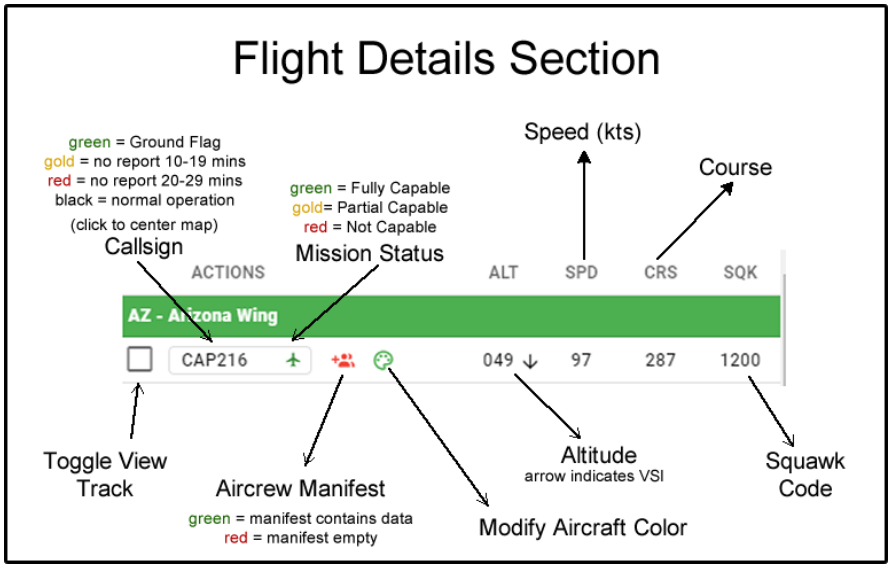


Component	Purpose
Zoom	Zoom allows you to zoom in and out on the map. Click the (+) will zoom in and clicking the (-) will zoom out.
Ruler	The ruler allows you to measure the distance in Nautical Miles (nm) between multiple points. This is useful when determining distance between current location and the mission base or between airports or grids, etc.
Lat/Lon Beneath Mouse	When you move the mouse around the map area, this section displays the current lat/lon of the spot directly below the mouse icon. This is useful if you need to provide lat/lon to another member or to the ground or aircrews. We provide this number in degrees, minutes and decimal seconds which matches the input type for many of our aircraft.
Map Layers	Clicking this button exposes a list of different map base layers; Google satellite, hybrid, roadmap, topo, VFR and IFR charts
View Live or Search Historical	These are displayed as tabs which allow you to switch between live and historical modes. Live mode is automatic where all active aircraft in Pacific Region are displayed, grouped by their wing. Notice that Live and Historical have a FILTER section. This is used to search within the aircraft that are already displayed. It is not to search the history for the aircraft, it is only used to shorten the list that is already being displayed.
Wing Header	This is how we group the aircraft that are currently active. Each wing has a specific color which corresponds with the map marker for each aircraft.
Aircraft	This is an example of an aircraft. The content is slightly different between Live and Historical modes, but the purpose is the same. It allows you to center the map over the aircraft, know if the aircraft hasn't reported, altitude, speed, course and squawk code. It also provides you the ability to enter the Aircrew Manifest, which contains information on the mission, pilot, observer, scanner, and other passengers.

Search for POI, Address or Coordinates	This field allows you to locate a point on the map. Simply type in what you are looking for and press enter.

Flight Details Section

There are some things to know about the flight details section. We display more information than just what you see here. See the details below.

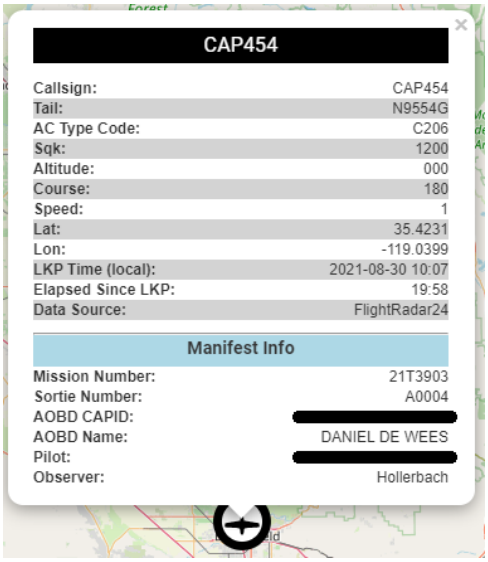


Component	Purpose
Toggle View Track	Checking this box will display the track line for the selected aircraft.
Callsign	This is a button with a call sign label. When you click the button, it will center your map directly over the aircraft. The border around the button also provides additional information. If the border is GRAY, that is normal operations. If the color is GREEN, that indicates the ADS-B is providing us with a flag that says the aircraft is on the ground. If the color is GOLD this indicates that we have not received a position report from the aircraft between 10-19 mins. Finally, if the color is RED this indicates we have not received a position report between 20-29 mins.
Mission Status	The mission status of the aircraft based on CAP GIS data. GREEN means Fully Mission capable, GOLD means Partially Mission Capable, RED means Not Mission capable
Aircrew Manifest	The aircrew manifest allows you to enter details about that specific flight: Mission Number, Sorties Number, Pilot Info, Observer Info, Scanner Info, and Pax Info. The color does have meaning here as well. RED indicates that aircrew manifest contains NO information. GREEN indicates that someone has entered some information in the manifest.
Modify Aircraft Color	This allows you to override the Wing Color for the aircraft and set a specific color for this individual aircraft.
Altitude	Displays the altitude (MSL).
Speed	Displays the Speed (kts)
Course	Displays the current course of the aircraft.

Squawk Code	Displays the discreet code assigned by ATC or 1200 for VFR

Aircraft Details

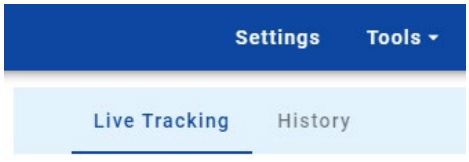
The image will explain the visual representation of the aircraft. There is also more information distributed that meets the eye initially. See the table below for detailed explanation of each item.



Component	Purpose
Data Tag	The data tag contains the callsign or tail number if no callsign is available. If there is a pilot listed on the aircrew manifest, the pilots' name will populate under the callsign in the data tag.
Marker	The marker is the representation of the aircraft. The ring around the aircraft corresponds to the Wing Group color in the flight details section. Another item to understand is the aircraft symbol in the center of the marker. This symbol has 8 possible positions that will represent the general course of the aircraft.
Detail Popup	The detail popup contains flight information and will most likely be where we add addition information/functions in the future. Any manifest information will also be display here. The header at the top also corresponds with the Wing Group color.

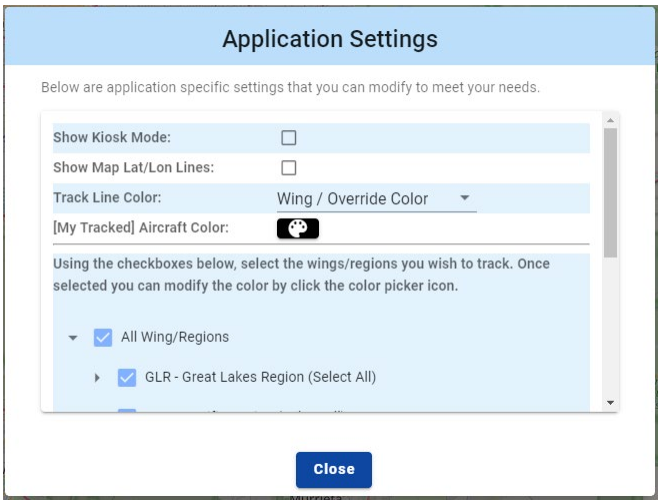
Settings Menu

The most recent addition to TRACS is the new Settings menu. The Settings menu item is used to select which wings you wish to include on your map. Once you select a wing to be included it will then allow you to click a color picker to choose the color representing the aircraft markers and wing heading in the right side bar are shown. You can have one color per wing and select as many of the wings as are available.



On the main screen:

1.) Click on Settings on the main menu



You will now see the Application Settings window. You can, turn on Kiosk Mode, Turn on the Map Graticules, set the Track Line color to either Same as the Wing Color or Black. You can also set the color of the Non-CAP aircraft you add to your screen, and finally use the checkboxes to the left of the wings/regions to include aircraft from those wings in your data. Once you selected a wing, you can then set a color at the wing level. All aircraft in that wing will have a marker of the color you choose and the heading on the right side will represent the same color you have chosen.

Once you have made all of your selections and set the colors:

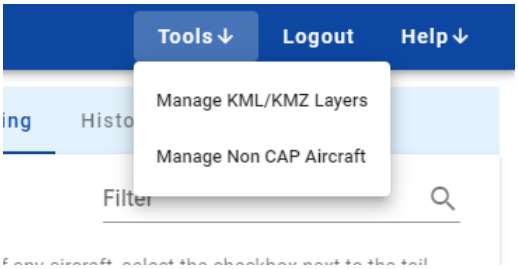
1.) Click the Close button.

Manage KML/KMZ Layers

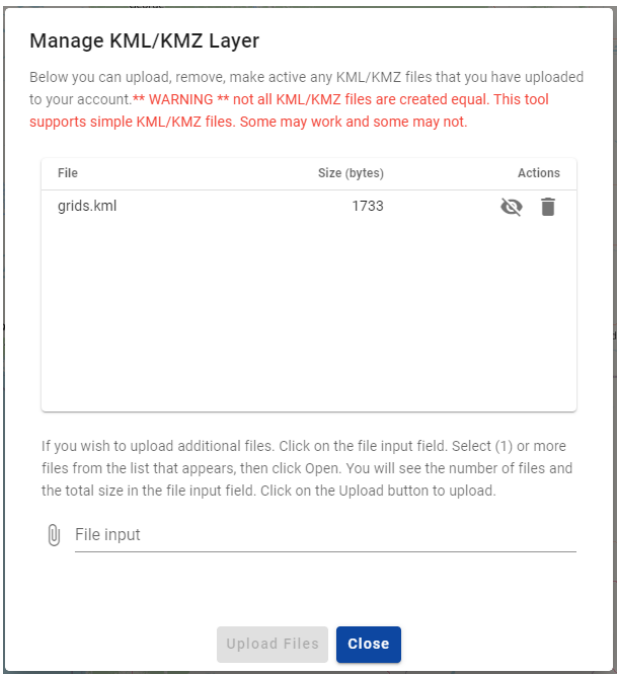
One of the primary goals of this version of TRACS was to provide a complete tool that can be used without having to have multiple tools running. Importing and exporting KML files was one of those things that many folks needed in the tool but used an external tool like Google Earth to supplement the missing feature. We have now provided this ability inside TRACS. We took it one step further, such as when you upload KML files, they are available to you no matter where you login to TRACS from in the future. You can access the feature by doing the following:

On the main screen:

1.) Click on Tools → Manage KML/KMZ Layers



You will now see the following screen appear. This is where you will manage the KML/KMZ files for your account. There is one important note we need to make right away. KML/KMZ files can be quite complicated and our tool must CONVERT from KML to a format that we can utilize. During this conversion process, there are a lot of features that do not translate very well. It is best to utilize simple, single layer KML files. We have tested the file sent by AFRCC and although the icons and colors change, the overall layout of the KML/KMZ content appear to convert just fine. However, we also tried the previous version of the CAWG Data Layers and it failed to import. The system basically will not show anything if there are too many items that fail the conversion process.



Once you see this screen, you can upload a file by:

2.) Click on the File Input at the bottom

You will be presented with a file selection screen, locate one or as many KML/KMZ files as you like then…

3.) Click on OK

4.) The Upload Files button will become active, click it and your files will be pushed into the cloud. You will see entries in the list for each file you uploaded.

To make the KML visible on the primary map…

5.) Click on the (EYE) icon. If the conversion is successful, you will see the content on the map.

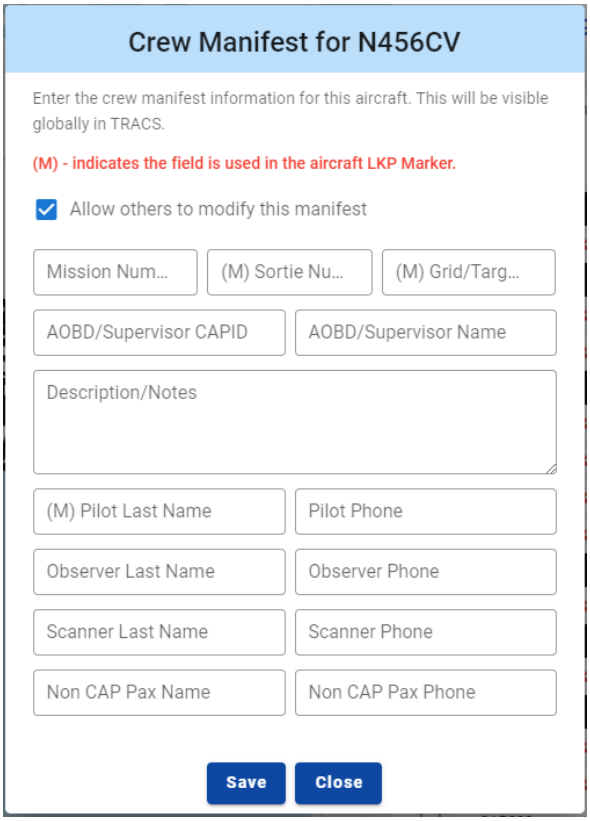
If you are ready to delete the KML…

6.) Click the Trash Can and it will be removed from the cloud.

Modify the Aircrew Manifest

The aircrew manifest is our way of solving the problem without having access to WMIRS data. This will allow the IC, AOBD, or whomever to tag the aircraft with the information that we would like to track.

Field	Value
Allow other to modify manifest	Allow / Disallow others from making changes to manfest.
Mission Number	Enter the mission number. Please make the mission number MATCH the format used in WMIRS
Sortie Number	Contains the sorties number. Please MATCH the format of WMIRS when entering the value here.
Grid/Target Area	Grid Number or Target area of search
AOBD/Sup CAPID	CAPID of AOBD
AOBD/Sup Name	Name of AOBD
Description/Notes	General Notes AOBD/Supervisor wishes to store in the record.
Pilot Name/Contact	Insert the pilot First/Last or just the last name and phone number
Observer Name/Contact	Insert the observer First/Last or just last name and phone number
Scanner Name/Contact	Insert the scanner First/Last or just the last name and phone number
Pax Name/Contact	Insert the additional Pax First/Last name or just the last name and phone number.



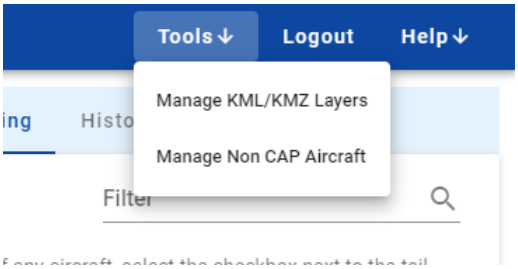
Once all of the data you wish to supply has been entered…

1.) Click the Save button.

After a few moments, you should see the pilot name appear in the data tag and any fields you supplied will be available in the Detail Popup. We have tried to make it as easy as possible to keep track of the flights/members you are responsible for.

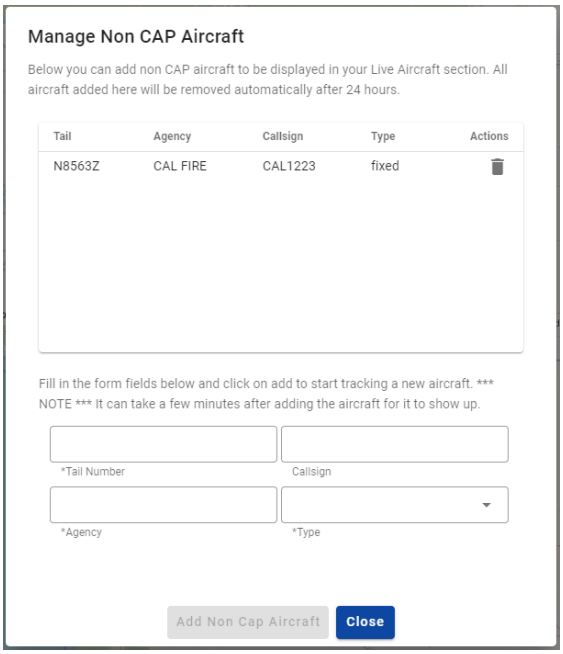
Manage Non-CAP Aircraft

There are times when we may be working with external agencies. They may have air assets that they are using as part of the overall effort. To keep our members in a single tool, we have provided the ability for you to add Non-CAP aircraft to your list of aircraft. These aircraft are only seen by you and will be automatically removed after 12 hours. This is to save space in the database. We are not capturing data for this aircraft when we no longer need to. To add a Non-CAP Aircraft, follow these instructions:



1.) Click Tools → Manage Non CAP Aircraft

You will now be presented with the following screen as seen on the next page.



Enter the information into the form. Below are details we are collecting and why.

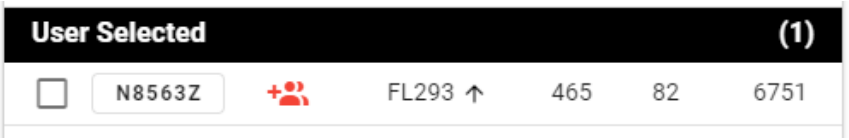
Field	Value
Tail Number	Enter the tail number of the aircraft you wish to add.
Callsign	This is the callsign that will be used by this aircraft. These are usually published, but if you don't know, ask.
Agency	Enter the name of the agency who manages this asset, Cal Fire, County Sheriff, Coast Guard, etc.
Type	Select either Fixed Wing or Helicopter

1.) Enter all the information into the fields, then...
2.) Click on Add Non-CAP Aircraft.

At this point, let's explain what is about to happen. We enter a record into our database that you are adding a specific aircraft to your watch list. We need to wait for the next poll for data of our ADS-B feed, and then we collect the data, store the records in our database, and then once it is in the database, it will appear on your watch list. This process can take maybe 1-2 mins at most. During testing this process only took 30-45 seconds, but it could take longer if we are tracking a lot of external aircraft.

Once the aircraft is added to you list, you will see a new Wing Grouping show up in **BLACK.** All **BLACK** icons will always represent Non-CAP (External) aircraft.

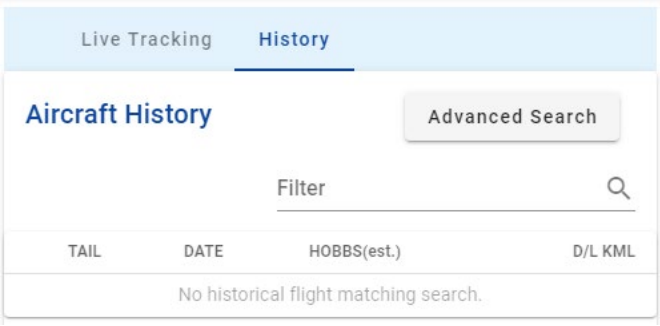
When you are ready to remove the aircraft simply go back into the Manage Non-CAP aircraft section and…



3.) Click the Trash Can to remove the Non-CAP Aircraft from your watch list.

Search Historical Flights

TRACS currently stores 3 months of previous flight information for any aircraft that was tracked during that time window. Searching for historical flights is easy. Here are the instructions to do a quick search:



1.) Click on the History tab at the top of the screen

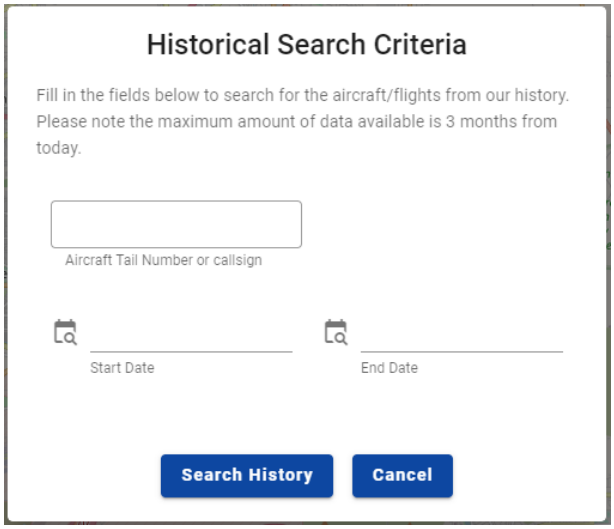
You will see the label change to Aircraft History and an advanced search button will appear.

2.) Click the Advanced Search button.

The following screen will appear to collect the information for your search.

All of these fields will be required to keep the number of results to a manageable size. Below we explain what the fields will contain.

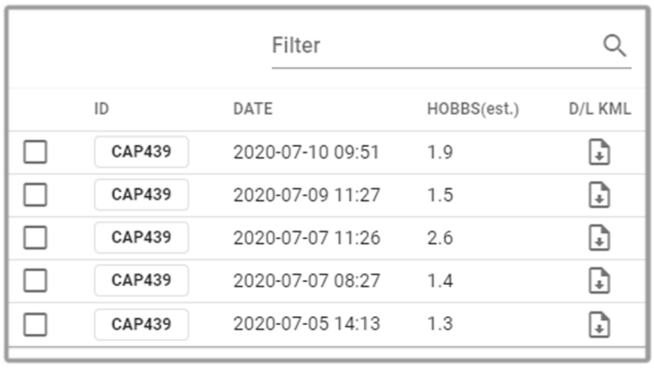
Field	Value
Aircraft Tail Number / Callsign	This will automatically detect if you enter the letter N as it will assume you are going to enter a tail number, otherwise it will be used as a callsign.
Start Date	Enter the start date of your search.
End Date	Enter the end date of your search. If you use the same date as start date, you will get 24 hours worth of data for that day.



3.) Click the Search History button and your results will be collected and then displayed in the list.

Search Results List

The search results will be placed into the same area as where the live results go. The main difference is the columns of data that will be displayed. The columns are Tail Number, Date of flight (with the newest on top), estimated flight time based on the difference between the first data point and the last data point. The final item is a button to download a KML file.



Field	Value
Checkbox	This turns on the tracking lines on the map for the flight showing the start and end point of the flight. The map will center on the start point automatically.
ID	Contains the callsign of the aircraft.
Date	Start date of the flight
HOBBS	Approximate flight time
DL/KML	Click this to download a KML of the flight.

Exporting a KML file of an Aircraft Track

The search results screen contains the list of the aircraft that meet your search criteria. The last column of the data contains a download icon. This icon is where you would click to download a KML file for that flight. We name the file to help you know what flight that KML was for. To download the KML:

1.) Click the D/L KML button next to the flight you want.
2.) Review the filename - {ID}-DATE-{DATE_OF_FLIGHT}-HOBBS-{HOBBS}.kml

Example Filename: N939CP-DATE-2020-07-07-08-27-HOBBS-1.4.kml

Mission Workflow

This tool has been designed to allow us to solve for a lot of deficiencies we have had tracking aircraft in the past. Below are the steps that we would expect any IC or AOBD to utilize to ensure a uniform way of managing our aircraft.

1.) Login to TRACS
2.) Brief and Release your crew (we cannot modify the Aircrew Manifest until they appear in ADS-B)
3.) Wait for Engine Start/Taxi (at most airports ADS-B is available on the ground)
4.) Locate the Aircraft (they will appear at some point)
5.) Click on the Aircrew Manifest icon to the right of the tail number/callsign
6.) Enter the Mission Number/Sorties Number
7.) Enter Pilot and Crew Information
8.) Save the Aircrew Manifest

Using this process will ensure that all flights during a mission or exercise will be tagged with a Mission Number and Sortie number so that we can review by looking at the history later. It also helps all involved to be able to click on an aircraft and know who the crew is on the plane. This is good for IC, OPS, AOBD, etc.

Status Board Workflow

The following is a workflow to explain how to utilize the new TRACS Status Board. **The most important thing to note is that the aircraft are only available once they show up in ADS-B. ADS-B data may be incomplete and/or not available for certain phases of the sortie, so it cannot be relied upon to provide event timestamps like engine start or wheels up automatically.** This tool is not designed to replace the current process nor the WMIRS comm log. It is to provide another layer of situational awareness and we have provided a very quick way for the Comm folks to update the status board. Please note this portion could also be done by an MSA that works closely with Comm.

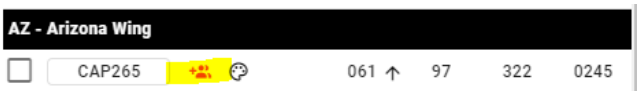
Required Data Entry

1.) The first step in the usage is to open and login to TRACS.

Once you have logged into TRACS, you can begin working with an aircraft when it appears in the active aircraft list. To keep your performance at its best only show aircraft for the wings you care about under the settings menu option.

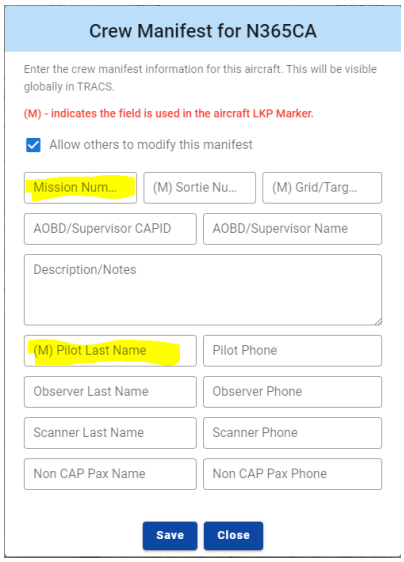
Before you can work with aircraft events, we need to know what mission number to associate this set of events with. Since we do not have WMIRS access this information needs to be input by you. We have limited this to (2) pieces of data.

2.) Click the Aircrew Manifest Icon



The next step is to enter the (2) required elements

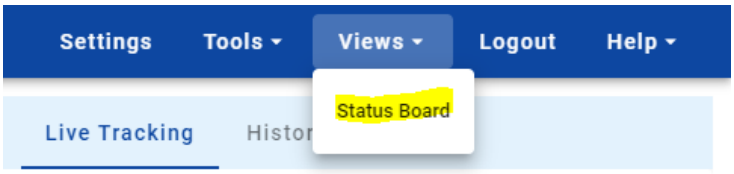
3.) Enter the Mission Number please do not use dashes, when entering the Mission Number please enter it in the format of 12T1234 or CAMISC, etc. Just leave the dashes out of the input.
4.) Enter the pilot's last name. This is important as it will show on the status board.
5.) Click Save



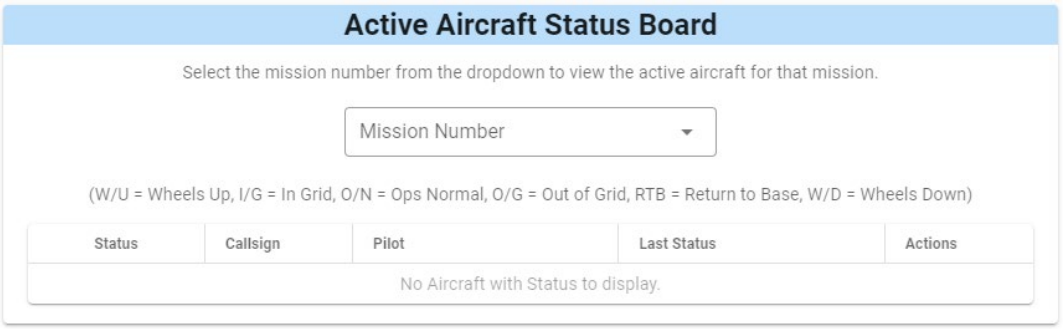
Once you click on save you will see the Aircrew Manifest icon turn green, meaning you have entered data into the field.

View the Status Board

1.) From the menu at the top of the screen click on Views → Status Board



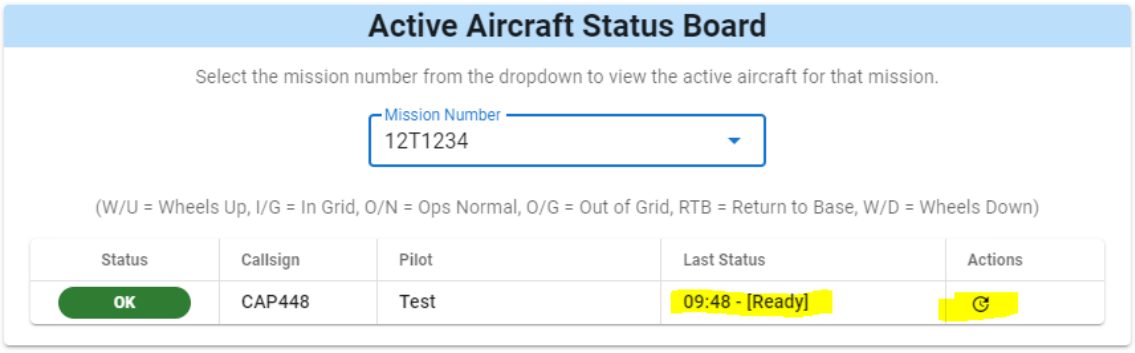
You will now see the following screen



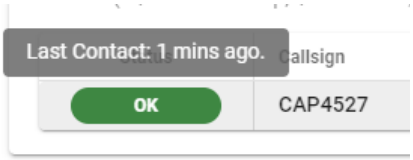
This is where you will see the status for the aircraft. You will first need to select a mission number and then all aircraft associated with that mission number that are currently active will appear on the status board.

2.) Select the dropdown for Mission Number and you will be presented all the mission numbers you can view.
3.) Select the Mission Number you wish to view.

You will now see the status board for that Mission Number as seen below



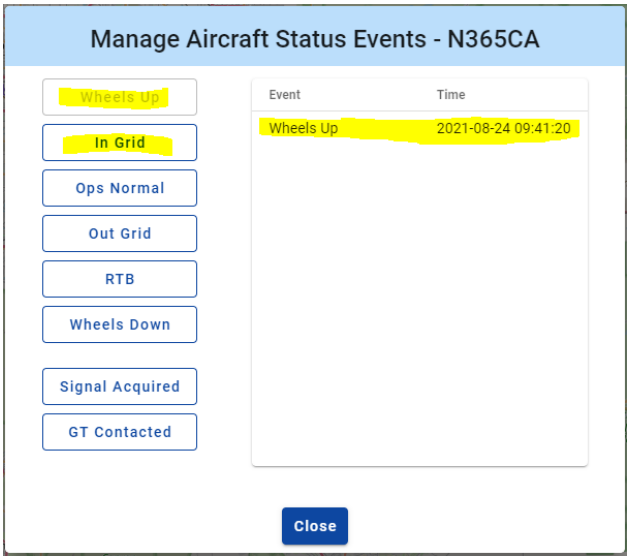
If you hover over the status, it will provide you with the time since the last update



Notice the Last Status shows the time and Ready. This simply means that the system is ready to accept status update events for this aircraft. Also notice the icon under the actions column.

4.) Click the Icon under the actions column for the aircraft you want to update the status for

5.) Click the Manage Aircraft Status Updates icon.



You will see a window with 8 buttons on the left and a list on the right. These buttons are the different status updates you can make for each aircraft. As you select an update (except for Ops Normal) that button will be disabled, since you can only have one entry with that status.

6.) Click the button representing the aircraft status you wish to add.

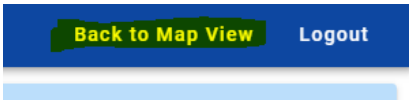
Notice the list to the right showing the event and the time of the event. This time does *NOT* need to match exactly to the Comm log, that would simply take to much time to manage. We really want a quick way of viewing the status of the aircraft and a min or two difference doesn't really change anything.

Once there is at least ONE aircraft for this mission that has at least ONE status entry, then this mission number and aircraft will be available to view on the status board.

The majority of this Status Board is self-explanatory, but the Status color codes need to be explained.

OK	Last status update added less than or equal to 30 mins ago
LATE	Last status update added greater than 30 mins but less than 60 mins ago
ALERT	Last status update added greater than 60 mins ago –initiate the missing aircraft process
COMPLETE	Wheels down status was added, flight is complete.

When you are finished with the status board, you can simply click the button to go back the map view on the main menu at the top of the screen.



Poor ADS-B Coverage Areas

ADS-B requires receivers on the ground to pick up the 1090 MHz signal from the aircraft. There areas where coverage could be spotty. We have (3) portable ADS-B receiver kits that can be deployed to the field to collect the ADS-B output from our aircraft operating in the area. While this is still not a perfect situation, it will provide us additional coverage should it be needed.

Technology

TRACS is based completely on Automatic Dependent Surveillance-Broadcast (ADS-B). Automatic Dependent Surveillance-Broadcast is a primary technology supporting the FAA's Next Generation Air Transportation System, or NextGen, which shifts aircraft separation and air traffic control from ground-based radar to satellite-derived positions. ADS-B Out broadcasts an aircraft's WAAS-enhanced GPS position to the ground where it is then displayed to air traffic controllers. It's also transmitted to aircraft with ADS-B receivers, either directly or relayed by ground stations, increasing the pilot's situational awareness. In the continental United States, ADS-B Out has been required since January 1, 2020.

TRACS is written using a common single page application framework using Vue JS JavaScript (Front-End), Microsoft SQL Server (Database), Redis caching layer to allow for many end users, and C# (API providing secure communication between front-end and database).

The mapping layer utilizes an industry standard mapping tool known as Leaflet. Leaflet is the leading open-source JavaScript library for mobile-friendly interactive maps. Leaflet contains all the mapping features most developers ever need.

Leaflet is designed with simplicity, performance and usability in mind. It works efficiently across all major desktop and mobile platforms, can be extended with lots of plugins, has a beautiful, easy to use and well-documented API and a simple, readable source code.

TRACS also takes advantage of Amazon CloudFront for caching, Simple Storage Service for storing user profile information, and Amazon Cognito which provide the interface between the front-end and our Azure Active Directory (Office 365) servers for authentication.