UNITED STATES SPACE COMMAND
Collision on Launch Avoidance Operations
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Launch Conjunction Assessment Handbook

Version 3.1 (Nov 2025)

USSPACECOM Process for Launch Conjunction Assessment

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KEY ORGNAIZATIONS

18th Space Defense Squadron

To provide a solid foundation for Space Domain Awareness (SDA), the 18th Space Defense Squadron (18 SDS) acts as a tasking authority for the Space Surveillance Network (SSN). It retains orbital-state-management (OSM) authority for every object in Low-Earth Orbit (LEO), Medium-Earth Orbit (MEO), Geosynchronous Orbit (GEO) and Highly Elliptical Orbits (HEO). To support this mission, 18 SDS maintains two distinct catalogs:

- **General-Perturbation (GP) catalog** – a collection of two-line element sets (TLE) that are quick, routine orbital updates used primarily as tip and queue/sensor tasking data.
- **Special-Perturbation (SP) catalog** , known as the **High-Accuracy Catalog (HAC)** – a high-precision data set of orbital state vectors used for detailed tracking and further analysis.

Together, these resources enable the squadron to task, monitor, and manage the full spectrum of space objects under its purview.

19th Space Defense Squadron

Leveraging the HAC, the 19th Space Defense Squadron (19 SDS) generates spaceflight safety data under USSPACECOM's SSA Data Sharing agreement. This data, which includes Conjunction Assessment (CA) and Collision on Launch Avoidance (COLA) information, is then delivered via Space-Track.org to satellite owner/operators (O/O) worldwide. Additionally, 19 SDS maintains its own GP catalog and, in partnership with 18 SDS, serves as the SSN tasking authorities for the SDA mission. The 19 SDS retains OSM authority for man-made satellites beyond GEO.

COLLISION ON LAUNCH AVOIDANCE AUTHORITIES

AIR FORCE INSTRUCTION 91-202 THE DEPARTMENT OF THE AIR FORCE MISHAP PREVENTION PROGRAM

This document provides overarching guidance on space safety for acquisition, testing, and life cycle operations of terrestrial, launch, and orbital space systems, and includes specific direction on the acceptable risk thresholds for launches executed from Air Force launch

ranges. It is applicable to all Department of the Air Force organizations that develop, test, or operate any space system, or who provide launch/range services for space systems, and requires that any entity launching an object to exceed 150km altitude from an Air Force range receive collision on Launch Avoidance Screening from 19 SDS. Launch entities must submit their launch plans and data through the 30th Space Launch Delta Safety Office at Vandenberg Space Force Base or the 45th Space Launch Delta Safety Office at Patrick Space Force Base.

TITLE 14 CODE OF FEDERAL REGULATIONS (14 CFR)

14 CFR sets forth the procedures and requirements applicable to commercial space transportation activities conducted in the United States or by a U.S. citizen or by a U.S.-licensed launch entity outside the U.S. In accordance with 14 CFR, the U.S. Federal Aviation Administration (FAA) requires that all launch entities receive launch CA from the U.S. Department of Defense. The full 14 CFR is available online at:

https://www.ecfr.gov/cgi-bin/text-idx?gp=&SID=ccae461521090c137b5134f855ad02bc&mc=true&tpl=/ecfrbrowse/Title14/14tab_02.tp

USSPACECOM SSA SHARING PROGRAM

Unites States Space Command (USSPACECOM), as the U.S. government entity responsible for space domain awareness (SDA) and space situational awareness (SSA), is committed to promoting a safe, stable, sustainable, and secure space environment through the sharing of SSA information known as the SSA Sharing Program.

USSPACECOM provides no cost SSA services at the basic, emergency, and advanced levels that cover the full scope of support needed through the lifetime of a satellite from pre-launch preparation to end-of-life disposal.

Basic SSA data and services are disseminated to the world through the website Space-Track.org, which is accessible to anyone with a registered user account. The following satellite positional data is held on Space-Track.org: two-line elements (TLE) and orbital mean-element messages (OMM), the satellite catalog (SATCAT), and satellite decay and reentry data.

Emergency SSA data and services are provided for any situation that could risk people, property, space missions, or national security. Emergency services are provided regardless of agreement and may include sharing information with other entities. These include anomaly support and emergency conjunction assessment (CA).

Advanced SSA data and services include, but are not limited to, anomaly support, launch support, on-orbit CA, COLA (Collision on Launch Avoidance which has replaced the term Launch Collision Avoidance or LCOLA), deorbit and reentry support, and disposal/end-of-life support.
Emergency and advanced SSA services are available at the basic emergency level and at the advanced level to all operators of active spacecraft who have signed SSA Sharing Agreements with USSPACECOM. For more information on SSA Sharing Agreements, visit www.space-track.org/documentation#/odr.

Space-Track.org

Space-Track.org (www.space-track.org) is USSPACECOM's public website for sharing SSA information with the global space community at the basic, emergency, and advanced levels. All satellite O/O's and launch providers should register for a user account to access the full scope of SSA data and services available through the SSA Sharing Program.

COLA Overview

The Collision on Launch Avoidance (COLA) process identifies close approaches between launch objects and other cataloged space objects.

It begins with satellite observations from the U.S. Space Surveillance Network (SSN), which includes a variety of sites and sensors throughout the world that detect, track, catalog and identify artificial objects in geosynchronous orbit and beyond. SSN observations are input into USSPACECOM's mission systems, which implements "Special Perturbations" (SP) orbit propagation theory.

Orbit determination (OD) is performed automatically multiple times per day to determine the position and velocity of every object in the catalog, which is then updated in the High Accuracy Catalog (HAC).
USSPACECOM then screens the launch trajectories provided by launch agencies or satellite operators against the rest of the HAC as well as owner/operator provided on-orbit ephemeris).

Each launch trajectory screened is referred to as a primary object, and all the other objects in the HAC are referred to as secondary objects. Secondary objects include inactive payloads, rocket bodies, debris, and analyst objects that are not in the public catalog or have not yet been integrated into the public catalog. Additionally, 19 SDS provides COLA against external Owner/Operator Ephemeris

The COLA screening includes the launch window and 180 minutes (three hours) post-launch per Federal Aviation Authority (FAA) requirements. The screening compares launch object trajectory files against two different sets of catalogued-object data:

1. HAC
    a. This is data from HAC, which is informed by the SSN and implements "Special Perturbations" (SP) orbit propagation theory and Orbit Determination (OD) to regularly update the position and velocity of objects in the catalog.
2. Operational Owner/Operator (O/O) Ephemeris Files
    a. O/O ephemeris files contain predicted orbital data provided by the Owner/Operator of a satellite. This data is also used in On-Orbit CA and often includes predicted maneuvers. All conjunctions generated using this data are based on miss-distance with Probability of Collision (PoC) if covariance is included in the Ephemeris.
    b. USSPACECOM does not consider O/O Ephemeris as part of the HAC and cannot confirm the fidelity of O/O Ephem. Due to inconsistencies in O/O-provided data, COLA results are labelled to ensure launch providers can see the difference between results generated using HAC data and results generated using O/O-provided ephemeris files. COLA screening results generated using O/O Ephemeris are labelled as "OOEphem" in the resulting closure windows.
    c. Data that is designated within the 799 nine-digit analyst number range reduces the COLA spaceflight safety gap which is defined as the period from when an object is launched to when it is integrated into the public catalog (formerly known as the "LCOLA Gap").

Requesting COLA Support

Per the updated DAFI 91-202, launch entities on U.S. Space Force ranges and all U.S. Space Force-controlled launches from any range shall accomplish COLA procedures accounting for all launched objects with an altitude capability equal to or greater than 150 km. All other launching entities may request it through the Orbital Data Request (ODR) process.

1. Submit a Form R-15, Launch Plan and Orbital Parameters, to 18SPCS.doo.launch@us.af.mil at least 15 days prior to launch. For new launch providers, it is recommended to notify via email above and below as least 45 days prior to launch
2. Register for an account on Space-Track.org.
3. Send an email to SPOC.SPACE.CustomerService@spaceforce.mil requesting a permissions-based LCA (annotated as LCA on Space-track) folder.
    a. This folder will be used to submit trajectory files and receive launch screening results.
    b. This folder will be accessible only to the launch entity and relevant USSPACECOM units.
4. Upload a Form 22, COLA Request, to your LCA folder.
    a. If you receive COLA services before, upload a Form 22 at least 15 days prior to launch.

   b. If this is your first time requesting COLA services, upload a Form 22 at least 30 days prior to launch to allow for review and testing if necessary.
5. Upload launch trajectory files to your LCA folder for each associated object.
   a. If you received COLA services before, upload the files within at least 7 days of launch.
   b. If this is your first time requesting COLA services, upload the files at least 30 days prior to launch to allow for review and testing if necessary. Test data should be representative of the actual launch profile to test process flows and processing times.

The Form R-15, Form 22, and ODR process are available at www.space-track.org/documentation#/odr.

COLA Screening Schedule

A. Launch Screenings
   a. USSPACECOM performs a minimum of one COLA screening based on the information on the Form 22 for the day of the launch.
      i. Launch entities may request up to two additional screenings, as early as 7 days before mission day (e.g. L-7; L-4; and mission day).
      ii. Entities also have the option to request up to three backup days (listed as secondary launch dates on Form 22). If secondary launch dates are listed, entities will receive screening results for both the primary launch date and their first backup date if requested on Form 22 (the first secondary launch date listed on Form 22).
   b. USSPACECOM will attempt to perform COLA screenings as close as possible to the requested delivery time but may perform the screenings earlier based on mission priorities.
   c. Day-of-launch screenings have priority over screenings for days prior to launch (e.g. L-4, L-7).
B. Launch Delays
   a. If launch is delayed, USSPACECOM will screen the next launch date listed on the Form 22 as well as the following backup day (as requested).
   b. If a launch is delayed again, this process will continue until all backup dates listed on the Form 22 have expired.
   c. **Entities must submit a new Form 22 to USSPACECOM and it must be received at least 24 hours prior to the updated primary launch date with updated trajectory files, if applicable.**

COLA Screening Timestep

Launch entities may request the frequency at which their trajectories are screened within the launch window:

- Top of every minute, +/- seconds

- Every 30 seconds
- Every 10 seconds
- Every 5 seconds
- Every second

Based on the size of the launch, USSPACECOM may need to advise customers and adjust timestep or other screening parameters to adjust for time limitations. Increased timestep frequency increases the processing time which could result in delayed results.

COLA Screening Volumes

Screening volumes (Table 1) are based on the distance from the launching objects trajectory. The volumes are dictated by DAFI 91-202 as the MINIMUM criteria that must be met. Operators can request larger data captures but must understand that this will increase processing time and potentially delay result delivery

TABLE 1: SCREENING VOLUMES

Object Type	Definition	Propagation	Stand-off Radius	Probability of Collision
Manned	Manned space stations, visiting vehicles	Duration of trajectory up to 3 hours of Mission Elapsed Time (MET)	200 km	1x10E-6 (0.000001)
Active satellites	Satellites performing operational mission (may or may not be maneuverable)	Duration of trajectory up to 3 hours of MET	25 km	1x10E-5 (0.00001)
All others	Debris, rocket bodies, inactive satellites	Duration of trajectory up to 3 hours of MET	2.5 km	1x10E-5 (0.00001)

COLA Screening Reporting Criteria

COLA customers will receive all close approach results identified within the screening volumes listed in Table 1 above unless otherwise annotated on Form 22 and in compliance with DAFI 91-202.

COLA Screening Results

A. COLA screenings results will contain a list of trajectories with close approach results with information for the following fields:
    a. Year
    b. Day of year
    c. Launch time
    d. Satellite catalog number of the secondary object
    e. Common name of the secondary object
    f. Status of secondary object (i.e. active or debris)
    g. Mission elapsed time (MET) in seconds
    h. Miss distance in km
    i. Probability of collision (if applicable)
    j. Screening volume
B. If there is no data listed under a trajectory file name, there are zero results within the requested screening volume for that file.
C. Results will be uploaded to the requesting launch entity's LCA folder on Space-Track.org in a single text (.txt) file that includes screening results for all the trajectories provided, sorted by trajectory, referred to as the "All Sorted" file.
D. If required, .res files can be generated in lieu of an All-Sorted file and sent via Secret Internet Protocol Network (SIPRNet). This is only applicable for operators that have the required access and need to know. Indicate this requirement on Form 22 under Item 7 - Additional Details.

Transition from COLA to On-Orbit Conjunction Assessment

Once a spacecraft separates from the rocket, it enters an early orbit phase until it has reached or maneuvered into its final orbit. At this point, it is in the on-orbit phase of operations.

USSPACECOM will provide on-orbit CA for active spacecraft in accordance with the Spaceflight Safety Handbook for Operators in accordance with SSA Sharing Agreements and applicable orbital data requests. It is encouraged for all operators launching a satellite to provide ephemeris for that object both during pre-cataloging phases utilizing a 799 number and post-cataloging phases utilizing the actual object number.

Conjunction Assessment of Reentering Objects

If a trajectory is provided for reentering a rocket body or other associated launch object, USSPACECOM will screen it, and report results in accordance with COLA parameters. This process occurs if there is less than eight hours of ephemeris data.

Trajectory Formats

Trajectories may be provided in one of three file formats:

1. CALIPER Trajectory
2. Free-Format Ephemeris
3. CALIPER Trajectory Covariance V2.0

The CALIPER Trajectory and Free-Format variations are used to input only ephemeris data (position and velocity), whereas the CALIPER Trajectory Covariance V2.0 input file includes both ephemeris and position covariance. The CALIPER Trajectory Covariance V2.0 file format is required for users who request probability of collision (PoC) metric in addition to a miss distance.

The following sections provide guidance on input file coordinate systems and characteristics that apply to all formats, followed by descriptions of each specific format.

Input Files – Coordinate Systems and Characteristics

SuperCOMBO/CALIPER accepts launch vehicle position and velocity in rotating Earth-Fixed Greenwich (EFG) coordinates. In this system, E is along the line of intersection of the true equator of date and the Greenwich meridian, G is through the true North Pole (normal to the true equatorial plane) and F completes the right-handed coordinate system. SuperCOMBO/CALIPER converts the EFG ephemeris to Earth-Centered Inertial coordinates of date, a frame referred to as "ECI" in the 18 SDS and 19 SDS community. In the conversion from EFG to ECI, SuperCOMBO/CALIPER incorporates UT1-UTC corrections through a timing constants file populated with values from the International Earth Rotation and Reference Systems Service (IERS) Bulletin A.

EFG differs from the crust-fixed Earth-Centered Rotating (ECR) frame in that EFG does not incorporate polar motion. Differences between the EFG and ECR frames are small, on the order of 15 meters or less. Note that EFG is used interchangeably with the NASA "TDR" coordinate system. ECR is USSPACECOM terminology; it is equivalent to the Earth-Centered Earth-Fixed (ECEF) and Earth-Centered Fixed (ECF) frames.
Position covariance is entered in a launch vehicle-centered frame, in either UVW or PTW coordinates. In the UVW frame, U ("radial") is the unit vector in the radial direction, W ("cross-track") is the unit vector normal to the launch vehicle's inertial orbit plane, and V ("in-track") is the unit vector which completes the right-handed coordinate system. (Despite the "in-track" descriptor, V is only coincident with the velocity when the launch trajectory is circular.) In the PTW covariance frame, T is the unit vector along the launch vehicle's velocity vector, W is again the unit vector normal to the launch vehicle's inertial orbit plane, and P is the unit vector that completes the right-handed coordinate system. PTW is the most easily visualized covariance frame for elliptical launch vehicle trajectories because the T direction is aligned with the launch vehicle's velocity.

The SuperCOMBO/CALIPER launch trajectory input file should have ephemeris/covariance points provided at sufficiently frequent time points that interpolation may be used with negligible errors. For boosting launch trajectories, an ephemeris/covariance point spacing of 10 seconds is recommended – although less than 10 second spacing could be needed if the trajectory contains large maneuvers. For non-boosting, non-maneuvering phases of a launch trajectory profile, larger ephemeris/covariance point spacing can be used.

Note that SuperCOMBO/CALIPER can accept launch trajectory files with variable ephemeris/covariance point spacing. Since launch vehicle velocity is used for both interpolation and for identifying potential conjunctions, SuperCOMBO/CALIPER requires that the launch vehicle velocity be realistic such that the EFG velocity represents the derivative of the EFG position. Also, the position and velocity ephemeris points should be relatively smooth and continuous (e.g., real world delta-Vs for maneuvers are acceptable but large deviations particularly those that are discontinuous step functions are not). For meaningful PoC calculations, the launching entity must provide realistic launch trajectory covariance. For responsible decision making based on Pc, the launching authority must be knowledgeable on the PoC metric and its use/limitations.

CALIPER

The CALIPER trajectory file allows for multiple launch times/trajectories to be represented in a single file.

There are two types of CALIPER formatted files that USSPACECOM can accept:
1. User-Defined Launch Windows: This format uses Form 22 to define the launch time for trajectory files submitted.

a. Under this configuration, the system ignores the launch time in the CALIPER file. Instead, it uses the launch time listed in Form 22, overriding the file launch time.
b. Trajectories are submitted as part of a mission under a collective launch window and each trajectory file undergoes screening based on the launch window stipulated in Form 22, regardless of any unique launch window specified within the trajectory files. The launch window declared on Form 22 applies to all trajectory files submitted for screening within that mission.
c. This method is particularly advantageous for launch profiles that maintain the same earth-fixed trajectory throughout the launch window, as it requires substantially less processing time.

2. File-Defined Launch Windows: This format is for launches targeting a specific insertion point, requiring the earth-fixed launch trajectory to vary as the launch window progresses.

a. This configuration is a slightly different approach whereby the launch times and varying trajectories are derived directly from the file and there are typically multiple launch times annotated within the file.
b. It is pertinent to note that if the earth-fixed trajectories vary with each successive launch time (for instance, if the launch azimuth changes for interplanetary launch opportunities), then all launch times/trajectories must be submitted within a single file.
c. Each mission necessitates an individual Form 22 submission, defined by the mission's name and launch window. The launch window on Form 22 should compare to what is defined per launch time within each trajectory. Form 22 is to be submitted alongside all trajectory files pertinent to the specified launch window. If a Form 22 is submitted with trajectory files that are for a different launch window, those trajectory files cannot be processed until they are resubmitted with a new Form 22 and corresponding launch window.
d. If the launch window changes but the trajectory files remain the same, launch operators can create a copy of Form 22, update the launch window, and resubmit it with the same trajectory files. Please note, each Form 22 should add something to the mission's name to differentiate between the different screenings (i.e. LAUNCH MISSION NAME-A, then LAUNCH MISSION NAME-B).

The rationale behind these protocols stems from system processes and the evolution of mission requirements, as COLA has expanded, and screenings have become more system intensive. The screening of trajectory files for missions is set up in a daisy-chain process with the corresponding launch window that supersedes any window specified within the trajectory files themselves. This can become an issue with some of the deep space/interplanetary missions if it's trajectory files are only viable during a certain limited time within the launch window. For example, when a trajectory file is only valid from 0450-0455 of a launch window and won't be used after 0455, it is still screened for the entirety of the launch window specified in the Form 22.

In the example below, two launch times are represented as "File Defined" launch times.

```
LAUNCH TIME: 2019  1 1520 3.000 LAUNCH AZIMUTH:  0.000 DISPERSION FILE:
  0.000  -3048.065  -1597.441  5352.179
     0.000000  0.000000  0.000000
    0.000000000 0.000000000 0.000000000
 10.000  -3048.246  -1597.518  5352.450
     -0.053000  -0.018000  0.067000
    0.000000000 0.000000000 0.000000000
 20.000  -3049.416  -1597.747  5353.492
     -0.196000  -0.026000  0.141000
    0.000000000 0.000000000 0.000000000
 30.000  -3052.425  -1598.001  5355.278
     -0.417000  -0.023000  0.217000
    0.000000000 0.000000000 0.000000000
```

```
 40.000  -3057.928  -1598.172  5357.776
    -0.690000  -0.009000  0.280000
   0.000000000 0.000000000 0.000000000
LAUNCH TIME: 2019  1 1521 3.000 LAUNCH AZIMUTH:  0.000 DISPERSION FILE:
  0.000  -3048.065  -1597.441  5352.179
    0.000000  0.000000  0.000000
   0.000000000 0.000000000 0.000000000
 10.000  -3048.246  -1597.518  5352.450
    -0.053000  -0.018000  0.067000
   0.000000000 0.000000000 0.000000000
 20.000  -3049.416  -1597.747  5353.492
    -0.196000  -0.026000  0.141000
   0.000000000 0.000000000 0.000000000
 30.000  -3052.425  -1598.001  5355.278
    -0.417000  -0.023000  0.217000
   0.000000000 0.000000000 0.000000000
 40.000  -3057.928  -1598.172  5357.776
    -0.690000  -0.009000  0.280000
   0.000000000 0.000000000 0.000000000
```

A line with the launch time separates each EFG trajectory. Launch azimuth and the dispersion file are not used. The first line of each ephemeris point record contains time since launch in seconds followed by the XYZ components of EFG position in km. The second line contains the XYZ components of EFG velocity in km/s. The third line is a placeholder for acceleration of the asset, but acceleration is not currently used.
Any single CALIPER trajectory for a given launch time must contain a minimum of 5 points and a maximum of 25000 points. The maximum number of seconds since epoch is 999999.999 seconds, equivalent to 11.574 days.

Free-Format (Standoff)

The second format is a concise, space-delimited, free-format. An example is provided below.

```
3896.280 13660.571 2408.228  0.000  2.374  5.095  0.020
3900.000 13669.394 2427.179  0.000  2.369  5.093  0.020
3930.000 13739.930 2579.652  0.003  2.333  5.072  0.030
3960.000 13809.394 2731.493  0.006  2.298  5.051  0.030
3990.000 13877.810 2882.693  0.009  2.263  5.029  0.030
4020.000 13945.204 3033.248  0.012  2.230  5.008  0.040
4050.000 14011.600 3183.149  0.015  2.197  4.986  0.040
4080.000 14077.022 3332.393  0.018  2.165  4.964  0.040
4110.000 14141.495 3480.973  0.021  2.134  4.942  0.050
4140.000 14205.041 3628.885  0.024  2.103  4.919  0.050
4170.000 14267.683 3776.126  0.027  2.073  4.897  0.050
```

```
 4200.000  14329.444  3922.691    0.030    2.044    4.874    0.050
```

This EFG file of positions and velocities is independent of launch time (Note: this format does not support RAAN Steering launches) Launch window start/stop/spans are entered within the SuperCOMBO/CALIPER program by USSPACECOM. Numbers are in standard double precision format (not scientific/exponential format).
The first column is time since launch in seconds. The next three columns are the XYZ components of EFG position in km. The last three columns are the XYZ components of EFG velocity in km/s.

CALIPER Trajectory Covariance V2.0

The elements of the CALIPER Trajectory Covariance V2.0 format are shown below:

CALIPER EPHEMERIS V2.0 COVARIANCE UVW (or PTW)
LAUNCH TIME: yyyy ddd hhmm ss.sss…
TimeSinceLaunchInSeconds X Y Z Vx Vy Vz
PosCov(1,1) PosCov(2,1) PosCov(2,2)
PosCov(3,1) PosCov(3,2) PosCov(3,3)

A sample CALIPER Trajectory Covariance V2.0 file is shown next:

```
CALIPER EPHEMERIS V2.0 COVARIANCE PTW
LAUNCH TIME: 2019 20 1105 35.986inidef
  0.000 -15614.190  9512.504  27201.506  -0.031674  -0.511889  -2.511603
     0.033489    -0.042779    0.112008
    -0.000589     0.000675    0.005907
 258.619 -15621.660  9378.301  26541.559  -0.025764  -0.526209  -2.592410
     0.033953    -0.045187    0.121013
    -0.000573     0.000669    0.006007
 510.329 -15627.212  9243.933  25878.882  -0.018003  -0.541701  -2.673392
     0.034352    -0.047596    0.130522
    -0.000543     0.000660    0.006000
LAUNCH TIME: 2019 20 1110 35.986inidef*
  0.000 -15614.190  9512.504  27201.506  -0.031674  -0.511889  -2.511603
     0.033489    -0.042779    0.112008
    -0.000589     0.000675    0.005907
 258.619 -15621.660  9378.301  26541.559  -0.025764  -0.526209  -2.592410
     0.033953    -0.045187    0.121013
    -0.000573     0.000669    0.006007
 510.329 -15627.212  9243.933  25878.882  -0.018003  -0.541701  -2.673392
     0.034352    -0.047596    0.130522
```

-0.000543 0.000660 0.006000

*Note: The second launch time is not required if the launch window is user defined and not File-defined.

A CALIPER Trajectory Covariance V2.0 file begins with 2 header lines.
Header line 1:

1 2 3 4 5 6 7 8

12345678901234567890123456789012345678901234567890123456789012345678901234567890
"CALIPER EPHEMERIS V2.0 COVARIANCE ccc"
ccc = covariance coordinate system in a launch vehicle-centered frame, specified as either "PTW" or "UVW".

- In PTW, T is along the velocity vector of the launch trajectory with W out-of plane and P completing the triad.
- In UVW, U is radial with W out-of-plane and V completing the triad.

Header line 2:

1 2 3 4 5 6 7 8

12345678901234567890123456789012345678901234567890123456789012345678901234567890
"LAUNCH TIME: yyyy ddd hhmm ss.sss…"

Launch time formats are self-explanatory. Note that the decimal seconds are double precision free-format and thus can contain more than 3 decimals.

Data Record Lines:
Although the ephemeris and covariance data records appear column specific and formatted, they are flexible, free-format. Numbers are space delimited and are entered as standard double precision notation (not scientific/exponential notation). The column

alignment in the example was added only to aid readability. A data record consists of 3 lines.

The first line consists of both the timestamp and ephemeris data in EFG coordinates. EFG is an Earth-fixed rotating coordinate system related to the true equator/mean equinox of date Earth-Centered Inertial system by a simple rotation about the Z axis (normal to the true equator of date). The second and third lines contain the 6 elements of the lower triangular of the position covariance matrix. Again, despite the appearance of a strict format in the example above, all numbers are free-format double precision, space delimited values, in standard notation (not scientific/exponential notation)

Data record 1:
TimeSinceLaunchInSeconds = time since launch, in seconds
X = X-component of EFG position in km
Y = Y-component of EFG position in km
Z = Z-component of EFG position in km
Vx = X-component of EFG velocity in km/s
Vy = Y-component of EFG velocity in km/s
Vz = Z-component of EFG velocity in km/s

Data Record 2:
The second data record contains 3 of 6 elements of the lower triangular position covariance matrix.
PosCov(1,1) = position covariance element in km^2
PosCov(2,1) = position covariance element in km^2
PosCov(2,2) = position covariance element in km^2

Data Record 3:
The third data record contains 3 of 6 elements of the lower triangular of the position covariance matrix.
PosCov(3,1) = position covariance element in km^2
PosCov(3,2) = position covariance element in km^2
PosCov(3,3) = position covariance element in km^2

The CALIPER Trajectory Covariance Format V2.0 can be used to generate Pc and miss distance results or only miss distance via stand-off radius mode. In this case, SuperCOMBO/CALIPER would use only ephemeris data. This file could also be used to

generate elliptical screening. In this case, SuperCOMBO/CALIPER would again ignore covariance data, using only the ephemeris data in the file.

Naming Trajectory Files

O/Os must name their files in the format shown below for proper procesing; otherwise, Space-Track.org will not accept the file and will return an error message. The file name format is:

<Year>_<Mission>_<LaunchObject>_<MetaData>_<FileFormat>.<FileExtension>

TABLE 2: TRAJECTORY FILE NAME CONVENTION

Data Field	*Description*	*Normative Value (N) or Example (E)*	*Obligatory*
Year	The two-digit year of launch.	(E) 22 for 2022 (E) 23 for 2023	Yes
Mission	Typically, the primary payload for the launch. Will be designated by 18 SDS.	(E) Telstar-18V (E) Iridium-6 (E) ICON (E) NROL-71	Yes
LaunchObject	The launch object or segment that the trajectory represents.	(E) PAYLOAD (E) STAGE2 (E) FAIRING (E) SKIRT-RING	Yes
MetaData	Optional additional information provided at the discretion of the launch. Often used to indicate deployment status or additional details on the variation of the file	(E) Pre-Deploy (E) Post-Deploy (E) NoBurns (E) Powered	No
FileFormat	Format of trajectory file. Must be one of three formats included in "Trajectory Formats" section: Stand-Off/Free-Format, or Covariance/CALIPER	(N) SO/FF (N) COV	Yes
File Extension	Indicates the type of file	(N) .txt	Yes

FILE NAME EXAMPLES

- 19_TELSTAR-18V_PAYLOAD_COV.txt
- 19_CRS-16_STAGE2_UNPOWERED_SO.txt
- 19_Iridium-8_STAGE2_NoBurn_FF.txt

Submitting Trajectory and/or Ephemeris Files

Space-Track.org is the most efficient and secure method of submitting ephemeris files on a recurring basis.

1. Register for an account on Space-Track.org.
2. Send an email to 18spcs.doo.customerservice@us.af.mil (or call +1-805-606-2675) and provide the following information:
   a. Indicate you are requesting a folder to upload trajectory and ephemeris files
      i. This is a permissions-based ephemeris folder for your organization that will only be accessed by relevant USSPACECOM personnel and the personnel you authorize.
      ii. You will have upload, download, and delete permissions to the folder on the Files Panel (Figure 1) on Space-Track.org.
   b. The name of your CDM/Organizational/Operator account on Space-Track.org
   c. The Space-Track.org usernames who will upload ephemeris files for your satellite constellation

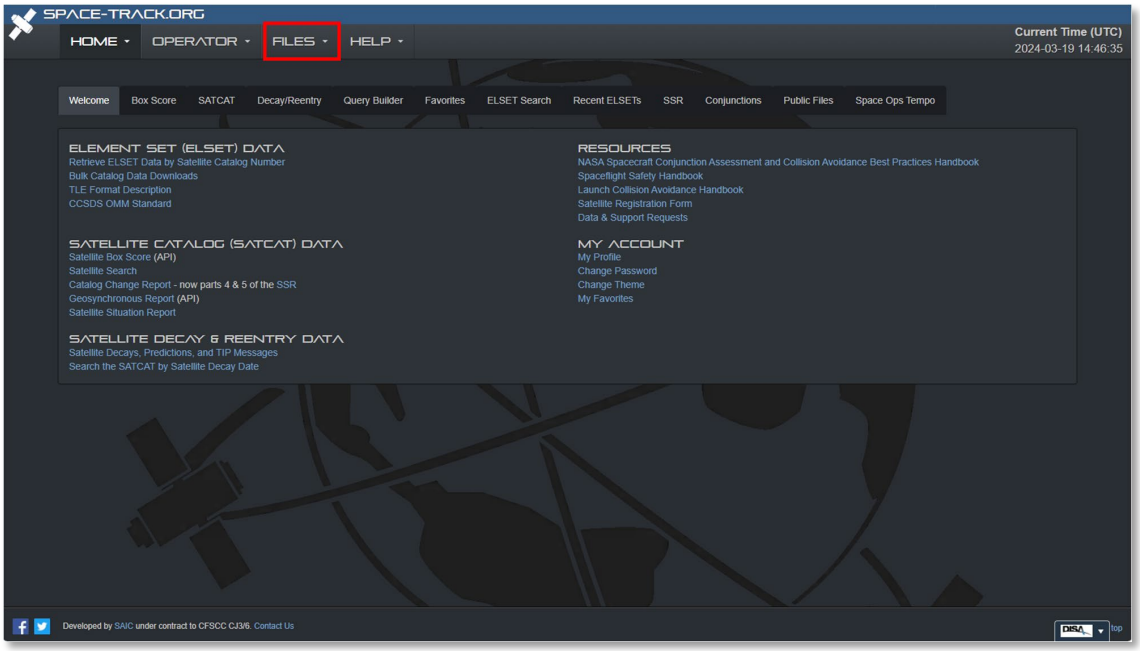

Figure 1. Space-Track.org Files Panel

Once the ephemeris folder is built, the Files panel will appear with 'Download' and 'Upload' selections in its mouseover menu (Figure 2).

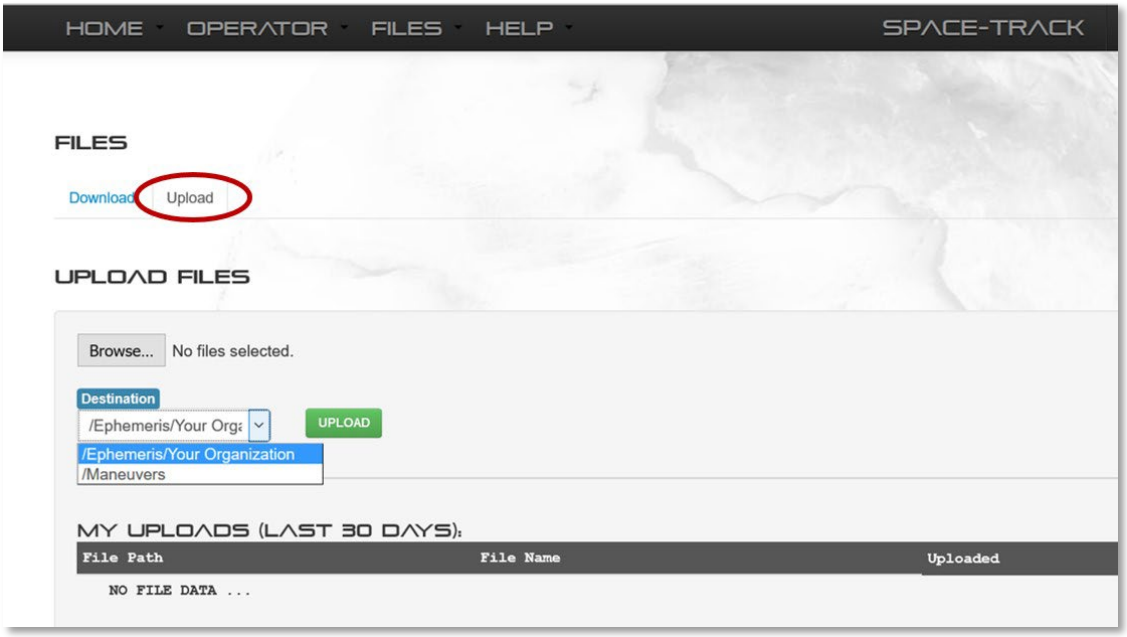

Figure 2. Destination Folder for Ephemeris File Uploads

1. Log in to Space-Track.org.
2. Mouseover the 'Files' panel and click on the 'Upload' tab
3. Click on the 'CHOOSE FILES' button and select your ephemeris files
   a. The maximum number of files in a single upload is 100
   b. The maximum total size per upload is 60 MB
   c. Files must be named appropriately (see **Naming Trajectory Files** section)
4. In the 'Destination' dropdown menu, select your /Ephemeris/' folder
5. Click the 'Upload' button
   a. Successful uploads will be displayed in 'My Uploads (last 30 days)' table
   b. A notification will be sent to USSPACECOM
6. If the ephemeris is 'Special' or for a high-interest event, email 19SDS.Orbital.Safety@spaceforce.mil (or call +1-540-284-3999) stating such

API Upload of Trajectory Files

For guidance on API processes, visit www.space-track.org/documentation#/howto.

Sending ephemeris files via email

Only use this back-up method for emergency reasons.

Send an email containing your ephemeris files along with a request for folders for trajectory and ephemeris files to 19SDS.Orbital.Safety@spaceforce.mil and 18SPCS.doo.launch@us.af.mil.

a. Files must be named appropriately (see **Naming Trajectory Files** section)
b. Only .txt files will be accepted. **.zip files cannot be accepted.**

For High-Interest Events

For high-interest events, upload your ephemeris files and then send an email 19SDS.Orbital.Safety@spaceforce.mil (or call +1-540-284-3999) with the following information:

1. The conjunction event
   a. CDM ID number
   b. Secondary object
   c. Time of closest approach (TCA/TOCA)
2. The object(s) to be screened against: one object, a list of objects, the whole catalog, etc.
3. Reference your approved ODR tracking number, if applicable
4. Confirmation of an SSA Sharing Agreement, if applicable

Downloading COLA Screening Results

COLA screening results are uploaded in the LCA folder (Figure 3) where the Form 22 and launch trajectories were uploaded as close to the screening time as possible.

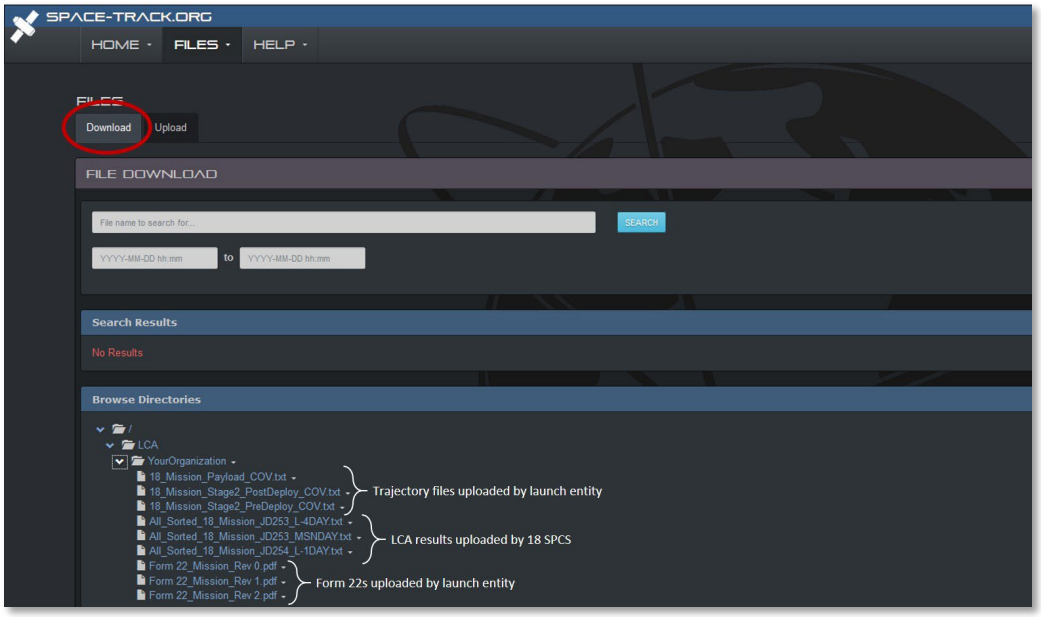

Figure 3. COLA Results

To receive email notifications when a file is uploaded on your LCA folder:

1. Login to Space-Track.org
2. Mouseover your username in the top right corner
3. Click on 'My Profile' from the dropdown menu
4. Click on the 'File' tab (Figure 4)
5. Click the 'Subscribe' button for your LCA folder

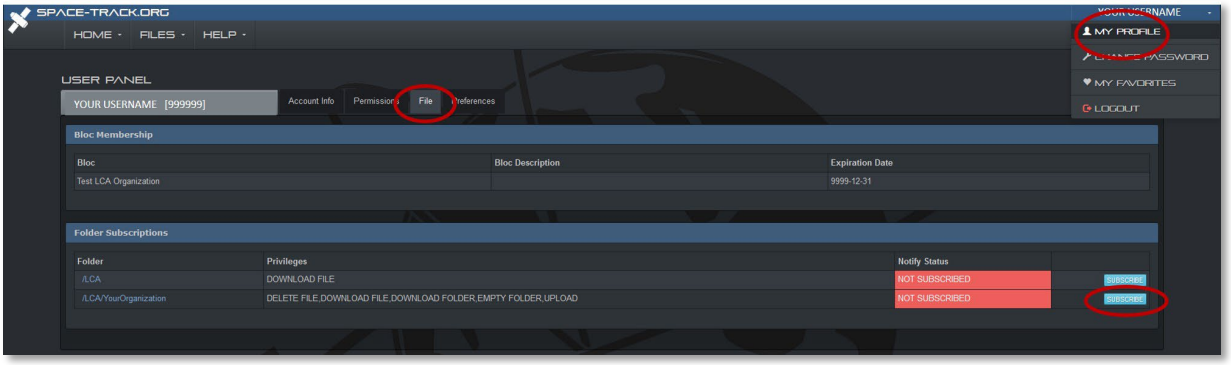

Figure 4. Folder Subscriptions

Contact Us

Topic	Samples	Contact Info	Office Hours
COLA and On-orbit Conjunction Assessment Support	* COLA or CA screening results * COLA or CA for high-interest events * Missing conjunction data messages (CDM)	19SDS.Orbital.Safety@spaceforce.mil +1-540-284-3999	24/7
SSA Data and/or Services	* Orbital Data Requests * Advanced SSA Data and/or Services * Space-Track.org access and/or permissions * Satellite registration for spaceflight safety support	SPOC.SPACE.CustomerService@spaceforce.mil +1-805-606-2675	Monday – Friday, 1500 – 2300 UTC
Space-Track.org	* Using the site's API * Automation processes * Website performance	admin@space-track.org or support@space-track.org	Monday – Friday, 1500 – 2300 UTC