SubT Integration Exercise (STIX) Operations Guide

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Defense Advanced Research Projects Agency
Tactical Technology Office
675 North Randolph Street
Arlington, VA 22203-2114

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1. Overview

This document serves as the Operations Guide for the SubT Integration Exercise (STIX) being held in advance of the DARPA Subterranean Challenge Tunnel Circuit. This optional event is an opportunity for qualified Systems Track teams to experiment on a representative course similar to the course planned for the Tunnel Circuit in August 2019. The STIX Event will be held in April 2019 at the Edgar Experimental Mine in Idaho Springs, Colorado, USA. The course elements and artifacts at STIX will be representative of those at the SubT Challenge Tunnel Circuit, but will not necessarily be exactly identical.

This Operations Guide is intended for qualified Systems Track teams planning to participate in the April 2019 STIX. The purpose of this document is to provide details regarding operations and logistics to ensure a successful and safe event.

As detailed in the _Qualification Guide_ document, teams were required to qualify prior to December 21, 2018, to be invited to participate in the STIX event.

STIX will be governed based on the rules as outlined in the draft *SubT Challenge Competition Rules (Tunnel Circuit)* document, so teams are encouraged to read that document closely for additional technical rules and restrictions. Questions related to the rules and any information provided in this Operations Guide may be posted to the SubT Community Forum (https://community.subtchallenge.com/).

STIX is designed with several goals in mind and the insights gained from the event will benefit all teams, not just those attending STIX. One goal is for teams to assess their current performance against environments and challenge elements similar to what is expected at the Tunnel Circuit. STIX will also provide teams the opportunity to test their integration with the DARPA testing infrastructure that will be used for scoring and evaluation in all future events. Finally, teams will be able to evaluate and test the integration of the DARPA-provided tracking infrastructure to ensure compatibility with their mobile platforms. While DARPA will be observing and collecting data during this event, all of the data will be for internal SubT Challenge planning purposes only.

2. Experimenting on the Course

Prior to operating their systems or experimenting on the designated test course, teams will be required to successfully demonstrate connectivity to their systems and the operation of both the Tier 1 wireless emergency stop as well as the Tier 3 on-platform emergency stop (if applicable) as detailed in the _Competition Rules (Tunnel Circuit)_ document. The Tier 2 recovery emergency stop capability will not be required for the STIX Event.

Teams will be given multiple opportunities to experiment on the test course over their two (2) days at the Mine. Teams will be assigned two (2) two-and-a-half-hour time slots for experimentation, and one (1) one-hour time slot for course testing. For the experimentation slots, the mine will be split into two sides. Teams will have the opportunity to test on each side during one of these two practice sessions.

DARPA Competition Staff will be available to support teams during these practice sessions. The intent of these practice sessions is for teams to test under competition-like conditions based on the Competition Rules. However, some reasonable accommodations may be considered during these practice sessions, provided safety and logistics concerns are addressed and approved in advance of the event.

On Day 3, teams will be given the opportunity to perform one (1) simulated scored run on the full test course. This course will be a combination of parts of the two practice courses as well as new sections. The score from this simulated scored run will not impact eligibility or provide any advantage in the Tunnel Circuit Event. The intent of the simulated scored run is for DARPA to evaluate the scoring infrastructure, gain insights into the scoring algorithm, and provide teams with insights to inform their development efforts.

At the end of Day 3, team members will be given a short walking tour of the mine to see the test course firsthand. Up to ten (10) members from each team will be permitted to participate in the course tour which is expected to be less than sixty (60) minutes including the safety briefing. Teams will be allowed to take photos and video as they complete the tour. Additional sensors may be brought as long as they are carried by hand and team members keep pace with the guided walking tour.

3. Task Operations

Teams will be responsible for moving their systems between the Team Operating Centers (TOCs) and the course Staging Areas, which is a distance of approximately 1200 ft (365 m). DARPA will work to assist the teams where possible, but Teams should plan to bring a utility vehicle to support movements.

During the practice sessions, team members can be in the Staging Area, at the Base Station, or TOCs. This is intended as time for each team to experiment on the test course. No team members will be permitted to enter the mine but DARPA Competition Staff will be available to assist with tasks such as platform recovery and any accommodations (e.g., sensor placement) that were previously approved. The Chief Official will have the final authority to determine if any team is operating in an unsafe manner or is not operating in the spirit of the SubT Challenge.

During the simulated scored run on Day 3, Teams will be permitted to have a single human supervisor at a Base Station external to the course, adjacent to the Staging Area. The Base Station is responsible, either automatically or with supervisor monitoring, for communicating with the deployed systems and relaying artifact reports and map updates to the DARPA Command Post.

Additional team personnel will be permitted in the Staging Area to serve as a "pit crew" to assist with operations tasks such as physically deploying the systems, performing repairs, and changing batteries. A limit on number of pit crew personnel may be imposed (e.g., due to site considerations). Once a team's run has begun, the pit crew personnel may not be substituted with other personnel outside of the Staging Area.

4. Schedule

Teams will be divided into groups to participate in STIX over a three-day period. Requests can be made for preferred dates and DARPA will accommodate requests where possible, but cannot guarantee a Team's first choice. Date preferences may be submitted by each Team's designated lead via the online STIX enrollment website (see Section 6).

Group 1: April 5 – 7, 2019
Group 2: April 7 – 9, 2019
Group 3: April 9 – 11, 2019

Day 1 – Jeffco Fairgrounds
Various	Teams travel
1800 – 1900	All enrolled Team Members check-in at Jeffco Fairgrounds
1900 – 2100	Team orientation

Day 2 – Edgar Experimental Mine
0745	First shuttle departs Idaho Springs city parking lot
0800 – 1000	Team arrival and set-up at Edgar Experimental Mine
1000 – 1230	Practice Sessions – Team 1 and 2
1230 – 1500	Practice Sessions – Team 3 and 1
1500 – 1730	Practice Sessions – Team 2 and 3
1800 – 1900	Hot wash
2000	Last shuttle departs Edgar Experimental Mine

Day 3 – Edgar Experimental Mine
0745	First shuttle departs city parking lot
0800 – 0900	Team arrival and set-up at Edgar Experimental Mine
0900 – 1100	Practice Sessions – (if necessary)
1100 – 1130	Reset of course
1130 – 1230	Simulated Scored Run – Team 1
1230 – 1300	Reset of course
1300 – 1400	Simulated Scored Run – Team 2
1400 – 1430	Reset of course
1430 – 1530	Simulated Scored Run – Team 3
1530 – 1600	Reset of course
1600 – 1700	Simulated Scored Run – (if necessary)
1700 – 1800	Hot wash
1800 – 1900	Course walking tour
1900 – 2000	Teams pack-up / depart
2000	Last shuttle departs Edgar Experimental Mine

5. STIX Location

STIX will be held at the Edgar Experimental Mine in Idaho Springs, Colorado. This site has been selected based on its ability to support the evaluation of Systems competition teams in an environment that is representative of the SubT Challenge Tunnel Circuit. Teams are not allowed to use or visit the Edgar Mine site from the time of this announcement until the completion of the STIX Event. Teams are also not permitted to contact the Edgar Experimental Mine for information related to the SubT Challenge.

Edgar Experimental Mine
365 8th Ave.
Idaho Springs, CO 80452

6. Enrollment

Teams are limited to 25 members in attendance at STIX. Each individual participant must enroll by 2359 EST on Friday, March 1, 2019. Qualified Teams will be emailed a link to the enrollment website.

7. Travel

The Denver International Airport (DEN) is the closest major airport and is about a 40-minute drive to the team orientation location, the Golden/Denver West/Lakewood region of Colorado. There is an additional 20-30-minute drive to the STIX test site, that is, the Edgar Experimental Mine (one-hour total from DEN). DEN is a hub for Frontier Airlines, United Airlines, and is a focus city for Southwest Airlines. It currently has non-stop service to 205 destinations throughout North America, Latin America, Europe, and Asia. Please note that Denver is at 5,280 ft. mean sea level (MSL) and Idaho Springs is at 7,526 ft. MSL, so everyone is encouraged to hydrate before and upon arriving in Colorado.
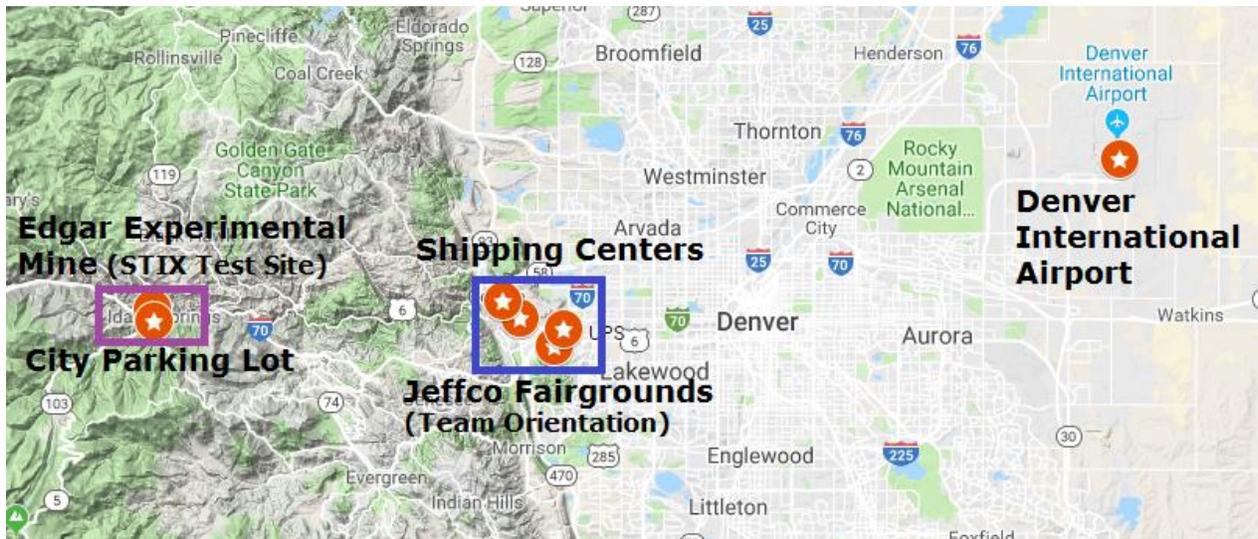
8. Area Maps

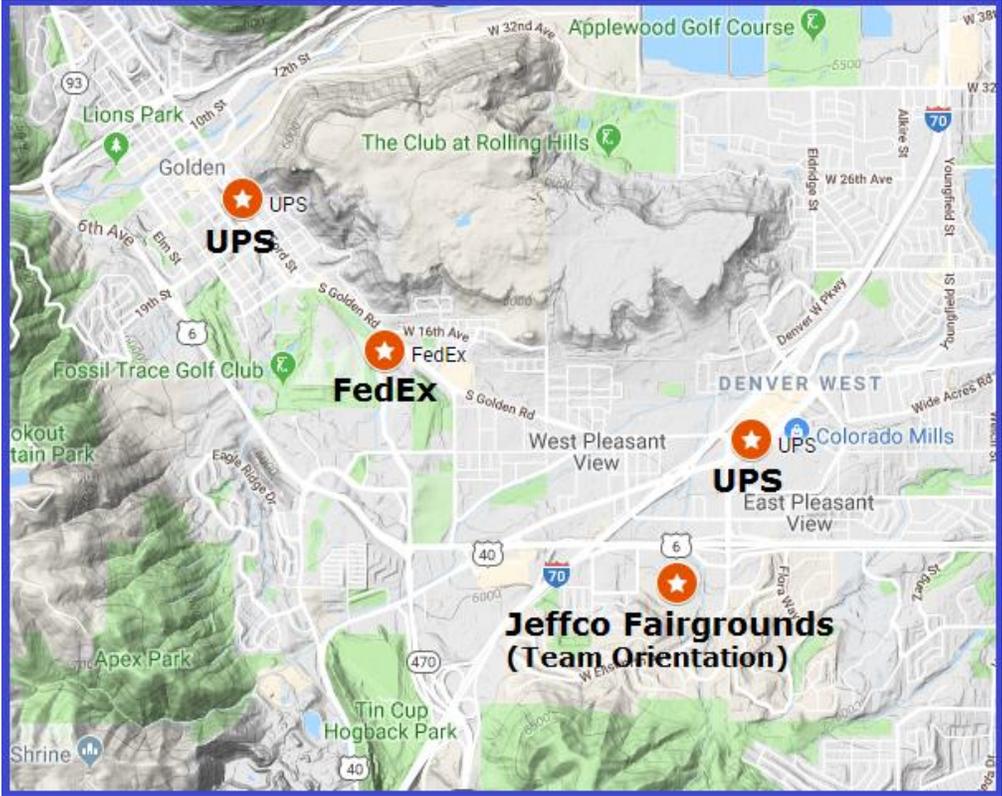*Figure 1: Denver Area Map with Key Locations*

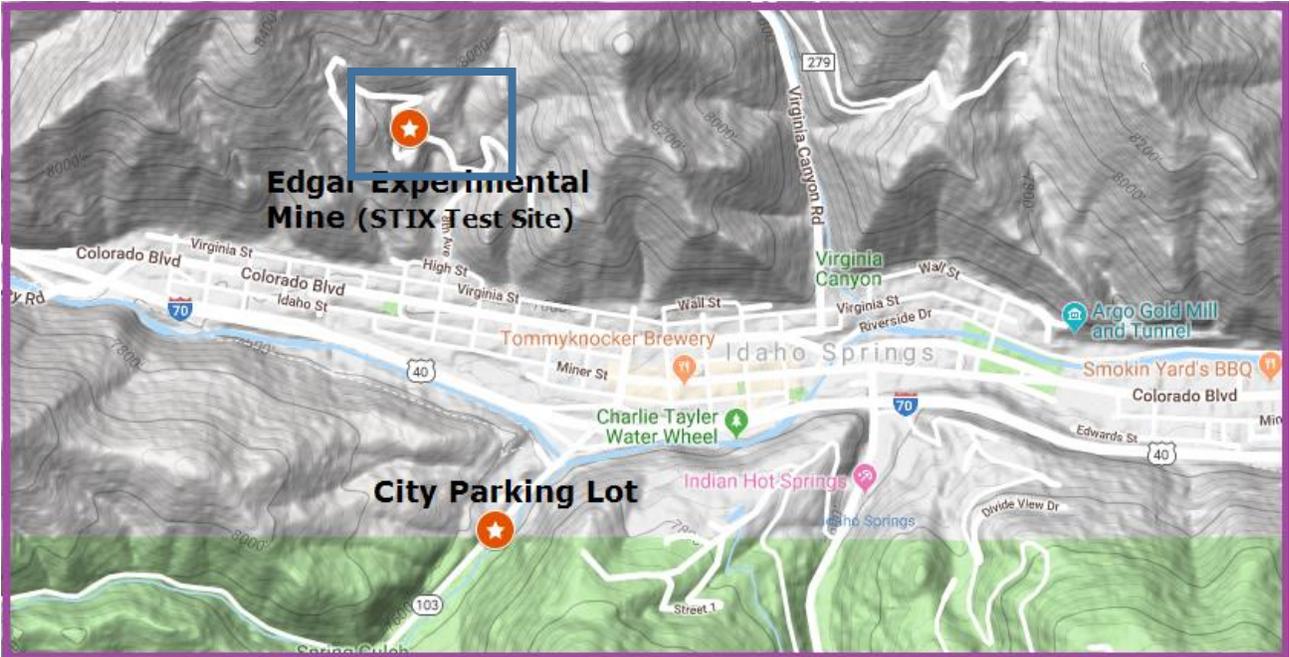*Figure 2: Golden, Colo. Area Map with Key Locations*

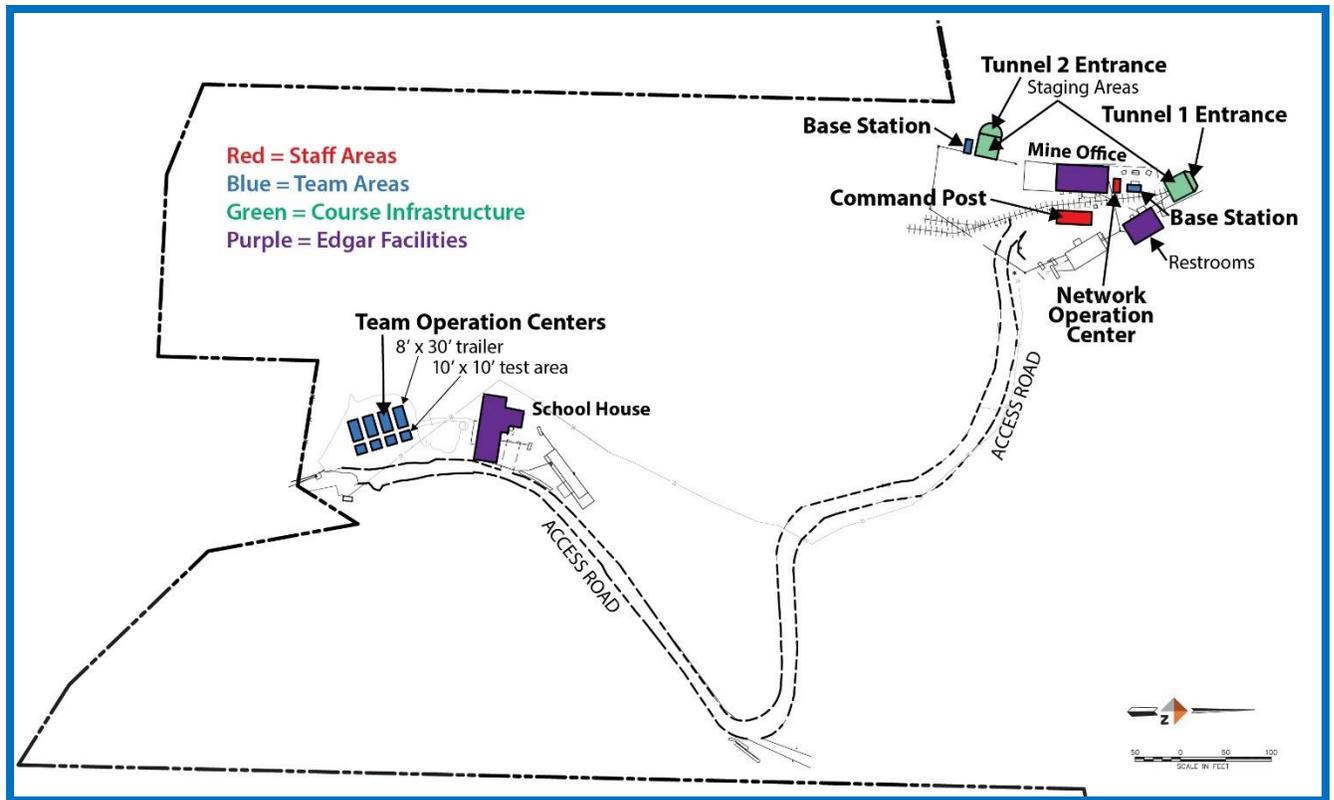*Figure 3: Idaho Springs, Colo. Area Map with Key Locations*

Figure 4: Edgar Experimental Mine Exterior Site Map

9. Lodging

Teams are responsible for making their own hotel reservations. Due to a large number of hotels in the area and teams having varying schedules, DARPA will not be reserving any hotel room blocks for teams. Hotels in the Golden/Denver West/Lakewood region are listed below, as there are minimal options in Idaho Springs. The hotel list is provided solely for informational purposes for the convenience of the teams. DARPA does not promote or prefer any of the hotels listed below.

Name	Address	Phone	Distance to Edgar
Hampton Inn Denver-West Golden	17150 West Colfax Avenue, Golden, CO	303-278-6600	23 miles
Holiday Inn Express & Suites Golden	17140 West Colfax Avenue, Golden, CO	393-278-2388	23 miles
Days Inn & Suites by Wyndham Golden/Denver West	15059 West Colfax Avenue, Golden, CO	303-557-1810	23 miles
Table Mountain Inn	1310 Washington Avenue, Golden, CO	303-277-9898	24 miles
Denver Marriott West	1717 Denver West Boulevard, Golden, CO	303-279-9100	25 miles
The Golden Hotel	800 11th Street, Golden, CO	303-279-0100	25 miles
Sheraton Denver West	360 Union Boulevard, Lakewood, CO	303-987-2000	27 miles
Homewood Suites by Hilton Denver West - Lakewood	139 Union Boulevard, Lakewood, CO	303-716-5737	27 miles

10. Team Orientation

All enrolled team members are required to attend the Team Orientation from 1900 – 2100 MST on the first day of their team's assigned group rotation. The orientation will be held in the meeting facilities of the Jeffco Fairgrounds in Golden, Colo.

[Jeffco Fairgrounds](#)
15200 West 6th Avenue Frontage Road
Golden, CO 80401

During orientation teams will receive:
1. Overview for STIX Event
2. Information on loading procedures
3. Exercise Details
4. Safety Brief

11. Move-in/Move-out

Teams may begin moving into Edgar Experimental Mine areas at 0800. MST on Day 2 of their scheduled rotation. Shuttles will provide round trip transportation from the city parking lot to the test site. The first shuttle will depart the city parking lot at 0745 MST.

Team operations onsite must conclude no later than 1800 MST on Day 2 and 1700 MST on Day 3. The last shuttle will depart Edgar Experimental Mine at 2000 MST on Day 2 and Day 3. Therefore, teams must leave the test site by that time. After completion of experimentation on Day 3, each team must return their workspace to its original condition.

12. Passenger Vehicles

Due to parking limitations at Edgar Experimental Mine, DARPA has reserved an Idaho Springs city parking lot located at [320 Colorado 103](#) (39.738690⁰N, 105.523006⁰W). DARPA will provide roundtrip passenger shuttles from the parking lot to the test site (one-mile distance). Each team is permitted to bring up to seven (7) passenger vehicles to the city lot. Parking passes will be distributed to the identified team leader at Team Orientation.

13. Equipment

All team robot systems and other required test equipment should be transported to Edgar Experimental Mine via one of two methods:

1) **Utility vehicle drop off** – Teams are permitted to bring one (1) passenger vehicle to the test site to deliver equipment and support their operations. These vehicles will park near the team trailers. Teams are encouraged to reserve a sport utility vehicle for easier access to the site due to the steep unpaved access road. Each team will be given one parking pass at Team Orientation for onsite parking at Edgar Experimental Mine.

2) **Shipping** – Teams are responsible for shipping their equipment to an outside provider as well as pickup and transfer of the equipment to and from the Edgar Experimental Mine. Due to liability reasons, Edgar Experimental Mine staff will be unable to receive or sign for any team shipments. Local shipping centers are listed below (see also Figure 2) for your convenience. DARPA does not promote or prefer any shipping provider below.

[FedEx Office Print & Ship Center](#)
17748 S Golden Road
Golden, CO 80401

[The UPS Store](#)
601 16th Street, Suite C
Golden, CO 80401

[The UPS Store](#)
14405 W Colfax Avenue
Lakewood, CO 80401

14.   Team Operations Center (TOC)

Teams will be provided an office-style trailer as their Team Operations Center for their time at STIX. Each trailer will notionally be 30 feet (9 m) long x 8 feet (2.4 m) wide x 7 feet (2.1 m) high with a vinyl tile floor. The trailers have two 30 inch (.75 m) wide doors. Each trailer will be outfitted with two (2) tables and twenty (20) chairs. No computers or monitors will be provided. Trailers will have heating, ventilation, and air-conditioning (HVAC) systems installed.

DARPA will provide power to the teams in two (2) locations: in the TOCs and in the course Staging Area. In the TOCs, there will be two (2) 120V, single-phase, 20A circuits, and in the Staging Areas, there will be a generator providing one (1) 120V, single-phase, 20A circuit. Both of these locations will have NEMA 5-20R T-slot receptacles. Teams should plan accordingly to have the correct adapters, chargers, and power strips to match their individual team needs. International teams should pay special attention to voltages common in the United States and bring any necessary equipment. If teams have additional power needs, they may bring or rent generators. If teams plan to bring additional power, they should inform DARPA via [SubTChallenge@darpa.mil.](#)

Immediately outside the trailer, each team will have access to a dirt area approximately 100 sq. ft. (9.2 m^2) in which they may operate their systems when they are not participating in a run on the test course. Teams are restricted from conducting flight operations in this area.

Teams are only permitted in the Staging Area during their scheduled runs and must otherwise remain in their TOC areas while onsite. A DARPA representative will be available at all times in the School House to answer questions or assist with onsite issues.

Figure 5: Representative TOC at STIX
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15.   Operational Considerations

The Edgar Experimental Mine is purposefully designed and used for experimentation with existing and emerging technologies. However, teams are responsible for assessing the potential dangers and/or real-world limitations of their technical solutions to be tested, in the context of safety to both personnel and equipment. If a team is unsure if a specific piece of equipment is allowable, the team should check with DARPA prior to arrival at STIX.

Standard radio frequencies (i.e., ISM bands) are permitted for use in and around the site. Teams should note that technologies that either require amplification or non-standard frequencies may be limited to within the mine and possibly not be allowed for use within the TOCs. Some useful resources can be found at https://arlweb.msha.gov/techsupp/commoandtracking.asp. If communication interference is discovered between systems, priority will be given to the Team(s) experimenting in the mine.

For teams looking to power their systems with fuel-based solutions, please note that diesel, liquid propane, and gases are allowed at small quantities. However, fuels such as JP-8, avgas, and standard unleaded are not permitted in the mine.

Teams operating drones or other aircraft should note that such aerial vehicles are not permitted to launch or fly in the vicinity of the TOCs. These platforms will be able to take-off and fly within the Staging Area for the purposes of entering the mine opening. Teams will be required to have a safety pilot and will have to coordinate the launch process to ensure no personnel are in the Staging Area when the aerial vehicles depart or return. DARPA will review a team's flight procedures during Day 2.

16.   Video Collection

DARPA intends to capture photographs and video during STIX for use in future production materials and to provide situational awareness of progress throughout the course. Team members may be asked to be interviewed on camera. Participation is optional, but encouraged, to provide a range of perspectives on the work being done in the competition. Teams may collect video and photographs of their systems operating within the Staging Area and their TOC. Teams are not permitted to take photographs or video of other teams' equipment or operations.

17.   E-Stops

DARPA has established a set of emergency-stop (E-Stop) requirements to ensure the safety of personnel, equipment, and the Circuit course environment. These requirements are designed to address common and/or anticipated modes of failure and provide a consistent, predictable method to disable equipment without creating additional hazards. All systems participating in the STIX Event will be required to demonstrate and utilize both the Tier 1 Wireless E-Stop and the Tier 3 On-Platform E-Stop as described in the *Competition Rules (Tunnel Circuit)* document. The Tier 2 Recovery Wireless E-Stop will not be required for the STIX event.

18.   Safety

A safety brief will be provided by Edgar Experimental Mine staff at the Team Orientation on Day 1. No manual physical intervention or entry by any (human) team members on the course will be permitted, except for the guided tour on Day 3. Only trained and authorized DARPA personnel will be allowed to enter the course preceding, during, and following any test runs. As a reminder, Denver is at 5,280 ft. mean sea level (MSL) and Idaho Springs is at 7,526 ft. MSL, so everyone is encouraged to hydrate before and upon arriving in Colorado to prevent altitude sickness.

Closed-toed shoes and protective eyewear will be required to be worn in the Staging Areas at all times. Protective eyewear will be provided by DARPA but teams are responsible for bringing their own shoes. Any additional Personal Protective Equipment (PPE) required for team tours of the mine will be provided by DARPA and/or Edgar.

19.   Security

The STIX site will be gated after event hours. Teams are still encouraged to secure their equipment at the end of the day in their TOC or return their equipment to their hotel for overnight storage.

DARPA is not responsible for any lost or stolen equipment. Nevertheless, acts of theft or sabotage will not be tolerated and will result in immediate disqualification.

20.   Food

Food and drink will not be provided at STIX. Teams are encouraged to bring food with them each day or plan to send a team member out during the day. There are several food options within Idaho Springs, about a five-minute drive from Edgar Experimental Mine. Please see the STIX enrollment website for a list of local restaurants.

21.   Weather

The weather in Idaho Springs during early April has an average high of 56°F (13ºC), low of 27°F (-3ºC), and averages approximately two inches of precipitation during the month. While the courses are underground, the movement between TOC and Staging Area is outdoors and periods of rain are possible. The DARPA team will be monitoring weather and may temporarily halt operations due to rain or inclement weather.