



# Engineering Assessment of HVAC Indoor Air Quality

Performance Verification for  
Energy Efficient Infection Control

## #0300 Astronomy Building

Fall 2021

Submitted by:

**Dhruvaraj Gambhire and Ali Khan**

Graduate Students: M Eng Energy Systems



STUDENT SUSTAINABILITY COMMITTEE



UNIVERSITY OF  
**ILLINOIS**  
URBANA-CHAMPAIGN  
Facilities & Services for Sustainability



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# 01. Project Overview

Our ability to verifiably measure indoor aerodynamics, ventilation, filtration and energy efficiency optimization to date, has been limited to static calculations and occupancy assumptions.

“Air required to be delivered to a given space by a Heating Ventilation and Air Conditioning (HVAC) system is based primarily on the number of people occupying the space, the type and amount of equipment, and the overall size of the space.”

*The National Institute for Occupational Safety and Health (NIOSH)*

The combination of our global pandemic and the daunting challenges associated with the unpredictable impacts of Climate Change, continues to fuel the need to identify scalable solutions to address these short, medium and long-term challenges.

Our project focuses on closing the healthy building knowledge gap by analyzing the impacts of:

- Indoor air changes and airflow dynamics
- Outdoor air supply/dilution
- Positive and negative pressurization impacts on infection control
- Current vs potential improvements to better optimize financial costs, human health and safety risks and Return-on-Investment (ROI) decisions.

This data informed audit of the existing HVAC system at the University of Illinois Urbana-Champaign - **Astronomy Building #0300**, will fully assess the practical application of the SafeTraces HVAC system performance diagnostic technology.

Our team, through the **Student Sustainability Committee/iCAP Plan** in collaboration with SafeTraces and its collaborative partner at Integrating Green Technologies, is respectfully submitting this project proposal for funding consideration.



## 02. Student Sustainability Committee (SSC) Funding Application



STUDENT SUSTAINABILITY COMMITTEE



UNIVERSITY OF  
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Facilities & Services for Sustainability



## STUDENT SUSTAINABILITY COMMITTEE

# Funding Application – Step II

### Funding Criteria

#### A. General Rules

1. Students, faculty, and staff are encouraged to submit requests for funding. Student-led projects require a faculty or staff sponsor in order to have funds awarded.
2. Funding can only go to university-affiliated projects from students, faculty, staff, and departments.
3. All SSC projects must make a substantial impact on students. This may be a direct impact or an impact through education and engagement. All SSC funding is 100% from student green fees, so the projects funded by the students must benefit them.
4. SSC encourages innovation and new technologies – creative projects are encouraged to apply.
5. Unless a type of expense is specifically listed below as having restrictions, SSC can generally fund it. The items referenced below should not be taken as a comprehensive list.

#### B. Things SSC Can Fund, On A Case-By-Case Basis

1. SSC can fund feasibility studies and design work; however, it must work toward ultimately addressing a sustainability need on campus.
2. SSC can fund staff positions that are related to improving campus sustainability. Strong preference will be given to proposals receiving matching funding from departments and/or plans for maintaining continuity of the position after the end of the initial grant.
3. SSC can fund outreach events with a central theme of sustainability, provided their primary audience is the general campus community.
4. SSC discourages funding requests for food and prizes but will consider proposals on a case by case basis that prove significant reasoning.
5. SSC can fund repairs and improvements to existing building systems as long as it works toward the goal of improving campus sustainability; however, a preference is shown to projects utilizing new or innovative ideas.
6. SSC can provide departments with loans for projects with a distinct payback on a case by case base. Loans will require a separate memorandum of understanding between SSC and departmental leadership pledging to repay the award in full and detailing the payback plan.

#### C. Things SSC Will Not Fund:

1. SSC will not fund projects with a primary end goal of generating revenue for non-University entities.
2. SSC will not fund personal lodging, food, beverage, and other travel expenses.
3. SSC will not fund any travel expenses.
4. SSC will not fund tuition or other forms of personal financial assistance for students beyond standard student employee wages.

**Your Step 2 funding application should include this application, the supplemental budget form, and any letters of support.** Please submit this completed application and any relevant supporting documentation to [Sustainability-Committee@Illinois.edu](mailto:Sustainability-Committee@Illinois.edu). The Working Group Chairs will be in contact with you regarding any questions about the application. If you have any questions about the application process, please contact the Student Sustainability Committee at [sustainability-committee@illinois.edu](mailto:sustainability-committee@illinois.edu).

## General & Contact Information

**Project Name:** Engineering Assessment of HVAC Indoor Air Quality:  
Performance Verification for Energy Efficient Infection Control

**Total Amount Requested from SSC:** \$11488 USD

**Project Topic Areas:**  Land & Water  Education  **Energy**  
 Transportation  Food & Waste  **Health & Human Safety**

**Applicant Name:** Dhruvaraj Gambhire and Ali Khan [Candidates M Eng Energy Systems]

**Campus Affiliation (Unit/Department or RSO/Organization):** College of Engineering

**Email Address:** DG [dvg3@illinois.edu](mailto:dvg3@illinois.edu) and AK [alifk2@illinois.edu](mailto:alifk2@illinois.edu)

**Check one:**

This project is solely my own **OR**

This project is proposed on behalf of (name of student org., campus dept., etc.):

**Facilities & Services University of Illinois at Urbana-Champaign**

### Project Team Members

Name	Department	Email/Phone
Dhruvaraj Gambhire	UIUC College of Engineering	<a href="mailto:dvg3@illinois.edu">dvg3@illinois.edu</a> +91 99304 37610
Ali Khan	UIUC College of Engineering	<a href="mailto:alifk2@illinois.edu">alifk2@illinois.edu</a> 217-991-2240
Sterling Laylock	Integrating Green Technologies	<a href="mailto:sterling@igt2030.com">sterling@igt2030.com</a> 305-849-7263
Michael Sheehan	Integrating Green Technologies	<a href="mailto:info@igt2030.com">info@igt2030.com</a> 404-474-1395
Carl H. Tutt, Jr	Integrating Green Technologies	<a href="mailto:carl@igt2030.com">carl@igt2030.com</a> 630-750-3786
Morgan B White	F&S for Sustainability	<a href="mailto:mbwhite@illinois.edu">mbwhite@illinois.edu</a>

### Student-Led Projects (Mandatory):

Name of Faculty or Staff Project Advisor: **Morgan B. White, Associate Director of F&S for Sustainability**

Advisor's Email Address: [mbwhite@illinois.edu](mailto:mbwhite@illinois.edu)

### **Financial Contact (Must be a full-time University of Illinois staff member)**

Contact Name: Mike Alsip

Unit/Department: Financial Reporting Coordinator

Email Address: [alsip@illinois.edu](mailto:alsip@illinois.edu), Phone : 217-244-4049

Mailing Address: Facilities & Services | University of Illinois at Urbana-Champaign  
1501 S Oak Street (MC-800) | Champaign, IL 61820

## Project Information

*Please review the proposal materials and online content carefully. It is highly recommended you visit a working group meeting sometime during the proposal submission process.*

**Please provide a brief background of the project, its goals, and the desired outcomes:**

*You may copy and paste your Step 1 application answer if nothing has changed.*

What started off as a proposal writing assignment for a class has now turned into an ambitious project.

Covid has drawn our attention towards efficient building ventilation. Existing solutions are inadequate to test air quality result in safety and facility professionals operating blindly with enormous building safety, occupational health, and financial consequences at stake. We will be collaborating with a company called SafeTraces. The project intends to verify ventilation and filtration performance in indoor spaces with real-world data. We will verify engineering controls and HVAC performance for airborne pathogens to keep people safe in any indoor environment. Balancing energy efficiency while delivering human life safety require some new tools.

We will develop and conduct test scenarios based on a set of realistic and representative conditions within the subject test building (Astronomy Building #0300).

Our testing design and implementation includes a survey risk assessment and dilution test assessments of specific locations within the building in order to identify potential hotspots, assess ventilation and filtration, verify area isolative efficacy, and inform remediations.

**Where will the project be located? Are special permissions required for this project site?**

*If special permission is required for this location, please explain and submit any relevant letters of support with the application.*

Subject test site is Astronomy Building #0300. Set-up and testing will be scheduled on a Saturday (Jan 2022), while the building is unoccupied. HVAC shall be running in normal operating mode during typical hours of operation.

**Other than the project team, who will have a stake in the project? Please list other individuals, groups, or departments affiliated directly or indirectly by the project. This includes any entity providing funding (immediate, future, ongoing, matching, in-kind, etc.) and any entities that benefit from this project.**

*Please attach letters of commitment or support at the end of the application.*

Project stakeholder collaborators include: Carl H. Tutt, Jr :: Michael Sheehan :: Sterling Laylock :: Integrating Green Technologies - Consultants representing SafeTraces Veridart Indoor Air Quality (IAQ) Assessment Technology

**How will this project involve and/or benefit students?**

*This includes both direct and indirect impact.*

**Direct Impacts:** a valuable solution for ensuring “real-world” pre and post-pandemic IAQ engineering controls and verifiable remediation protocols in order to protect occupant health and safety while minimizing disruptions to building and business operations. This is also a valuable solution for applied, hands-on design instruction and operational system performance measures for mitigating financial downside risk by ensuring the highest health and safety conditions in buildings.

**Indirect Impacts:** Health, safety risk mitigation and operational management of engineering systems. Improve informed financial decisions specific to ongoing operations, maintenance and capex improvement/replacement costs and their Return-on-Investment (ROI).

**How will you bring awareness and publicize the project on campus? In addition to SSC, where will information about this project be reported?**

We will take guidance of our Program Coordinator of the Masters in Engineering – Amy Jeanne. We will publicize this via the Universities’ mailing list for the respective program. We will inform students about our results and also bring attention to SSC’s effort via the SSC’s funding program. It will engage students to understand further issues on campus and encourage students to propose solutions via this activity

## Financial Information

*In addition to the below questions, please submit the supplemental budget spreadsheet available on the Student Sustainability Committee [website](#). Submission of both documents by the submission deadline is required for consideration of your project.*

**Have you applied for funding from SSC before? If so, for what project?**

NA

**If this project is implemented, will you require any ongoing funding required? What is the strategy for supporting the project in order to cover replacement, operation, or renewal costs?**

*Please note that SSC provides funding on a case by case basis annually and should not be considered as an ongoing source of funding.*

Ongoing funding will be required as we expand our ability to collect verifiable, indoor air quality data within our project site (Astronomy Building #0300). The budget that has been submitted is specific to the pilot project. As part of the deliverables, we will be submitting suitable recommendations the university should consider. We will approach the SSC for extra support after this activity is successfully carried out. We will require the extra support to implement the recommendations.

**Please include any other obtained sources of funding. Have you applied for funding elsewhere?**

*Please attach any relevant letters of support as needed in a separate document.*

*Not Applicable*



## Environmental, Economic, and Awareness Impacts

How will the project improve environmental sustainability at the Urbana-Champaign campus? If applicable, how does this project fit within any of the [Illinois Climate Action Plan \(iCAP\)](#) goals?

- **iCAP 2020 objective 2.2.2:** *“Reduce the total annual energy consumption of each college-level unit by at least 20% from an FY15 baseline by FY35.”*

Providing ongoing measurement and monitoring of performance metrics of the HVAC system will effectively reduce energy consumption.

- **iCAP 2020, objective 7.1:** *“Enhance the overall culture of sustainability on campus, and increase the number of certifications issued through the Certified Greener Campus Program by 20% each year from FY20 to FY24.”*

Maintaining ongoing measurement and monitoring of performance metrics of the HVAC system is prerequisite for many building certifications. ie: LEED, UL Verified Healthy Buildings, WELL Health and Safety v2 and WELL Certified Buildings.

- **iCAP 2020, objective 9.2:** *“Commit to a Sustainable Investing Policy by FY24.”*

Maintaining ongoing measurement and monitoring of performance metrics of the HVAC system allows for targeted facilities spending to optimize operational performance, financial prioritization and Return-On-Investment (ROI).

**How will you monitor and evaluate the project’s progress and environmental outcomes? What short-term and long-term environmental impacts do you expect?**

*Some examples include carbon emissions, water conservation, green behavior, and reduced landfill waste.*

Building a rich set of data on the indoor environment is key to the effectiveness of this initiative. SafeTraces analysis can provide a verifiable snapshot of the indoor air-quality environment. It can also provide a roadmap that pinpoints underperforming high-risk areas in need of immediate and near-term corrective-action.

Implementing monitoring for airborne contaminants over time informs the effectiveness of the remedial actions and empowers the Facilities Department to maintain the highest quality indoor environment. This is paramount in maintaining the health and wellbeing of the students and staff at UIUC.

**What are your specific outreach goals? How will this project inspire change at UIUC?**

Our outreach goals are designed to cause all stakeholders to recognize the importance of cost effective, scalable opportunities to provide the highest quality indoor environments. Specifically, the F&S leadership is involved in this effort and will receive the summary reports and discuss the recommendations made in the pilot process. This includes, Rob Roman, Director of Utilities & Energy Services, Jim Sims, Director of Engineering and Small construction; Dave Boehm, Director of Building Maintenance and grounds; and Dr Ehab Kamarah, Director of Capital programs and Interim Executive Director of F&S.

Tracking data over time supports the optimization of objective operational financial decisions that can contribute to a change towards “people-centric” methodologies for overall Indoor Environmental Quality (IEQ).

This is a paradigm shift in how decisions can be made regarding the design of new structures, renovation of existing structures, and their occupancy, as we continue to contend with the combined impacts of the Covid-19 global pandemic and the unpredictable effects of Climate Change.

**If applicable, how does this project impact environmental injustice or social injustice?**

If ignorance is the root of injustice, then knowledge is the foundation of empowerment. Employing the rich data sets from this level of diagnostic, verifiable, performance-based technology and ongoing monitoring, the UIUC Facilities & Services for Sustainability Department can have access to advanced tools to optimize its Indoor Environmental Quality (IEQ) decision-making.

Deploying this level of actionable data can allow UIUC Facilities & Services to maximize the efficient use of resources to improve the health, wellbeing and peace of mind for the entire campus population and its visitors.

Key aspect of this project is that the vendor is a minority owned business, which supports the universities goals to increase diversity in the vendors for campus activities.

Students, faculty and staff can also benefit from data transparency while simultaneously confirming that the reduction of Greenhouse Gas Emissions (GHG) necessary to contend with the challenges of Climate Change, isn't happening as a result of compromising their rights for equitable human life safety.



Graphic Courtesy of US EPA



## **03. Astronomy Building #0300 Proposal and Field Characterization**





# Integrating Green Technologies

## ASTRONOMY BLDG #0300

UL QUOTE DATE:

ST QUOTE DATE:

<b>IGT Project Manager</b>  Mike Sheehan 404-474-1395 info@igt2030.com	<b>Project Number</b>	#0300 :: UIUC Astronomy Building	<b>DATE:</b>	11/19/2021
	<b>Client Name :</b>	Morgan White, Associate Dir. of F&S for Sustainability	<b>SURVEY</b>	
	<b>Phone:</b>	217-333-2668	<b>ANALYSIS</b>	
	<b>Email:</b>	mbwhite@illinois.edu	<b>VERIFY</b>	

<b>Building Address:</b> 1002 W Green St, Urbana, IL 61801		
<b>Use:</b> Classroom / Office		
<b>Mailing Address:</b> F&S   UIUC - 1501 S Oak Street (MC-800)   Champaign, IL 61820		
<b>Notes:</b> #0300 UIUC Astronomy Building - 2 story building housing academic offices, small classrooms, library, laboratory and other common areas.  Hours of Operation - Monday to Friday (0800 hrs-1700 hrs.). Saturday and Sunday the building is closed.  For materials and supplies required see detailed budget.		



Indoor Air Quality Assessment (IAQ). Health and safety risk assessment for airflow, ventilation, and filtration performance. Provide a baseline survey for airborne pathogen mobility throughout the total test area. Provide dilution test for airborne pathogen mobility in specific rooms.

HVAC Specification: (provided by UIUC facilities)  
 Original Air Handling Unit (AHU) from 1990, Trane Model 41A, Serial K89H24684. Original AHU equipment schedule attached. AHU controls were originally pneumatic, upgraded to DDC (Siemens) in 2016 to allow occupancy schedules to be implemented. Zone level (VAVs) are still pneumatic. I believe the fume hoods are only energized when in use. Heating in the building is hot water radiators and hot water VAV reheat (no heating coil at AHU) fed from hot water boilers. 30% glycol cooling coil in AHU, fed from the air-cooled chiller on site.

Outside Air (OA)  
 AHU has a minimum OA position and runs based on an occupancy schedule.  
 Air Changes - TBD

**VERIDART TEST PLAN**

SECOND FLOOR - BASELINE SURVEY TO ESTABLISH CURRENT BUILDING PERFORMANCE.  
 8 ORIGIN PT. / 12 SAMPLE PT. - AIR SAMPLE ONLY

- DILUTION TEST SCENARIOS - AIR SAMPLE ONLY
- D1 - 112 MEN'S RESTROOM 10/20/30/40 MINUTE INTERVAL
  - D2 - 109 WOMEN'S RESTROOM 10/20/30/40 MINUTE INTERVAL
  - D3 - 134 CLASSROOM 05/10/15/20 MINUTE INTERVAL
  - D4 - 214 MEN'S RESTROOM 10/20/30/40 MINUTE INTERVAL
  - D5 - 222 BRAKE ROOM 05/10/15/20 MINUTE INTERVAL
  - D6 - SECOND FLOOR CORRIDOR (NO VENTILATION) 05/10/15/20 MINUTE INTERVAL



<b>IGT Project Manager</b> Mike Sheehan 404-474-1395 info@igt2030.com	<b>Project Number</b>	#0300 - UIUC Astronomy Building	<b>DATE:</b> 11/19/2021
	<b>BUILDING ID:</b>	1002 W Green St, Urbana, IL 61801	<b>SURVEY</b>
	<b>FLOOR LEVEL</b>	Second	<b>ANALYSIS</b>
	<b>TEST TYPE:</b>	Survey 8 OP / 12 SP	<b>VERIFY</b>



SECOND FLOOR - BASELINE SURVEY TO ESTABLISH CURRENT BUILDING PERFORMANCE.  
 8 ORIGIN PT. / 12 SAMPLE PT. - AIR SAMPLE ONLY

<b>IGT Project Manager</b> Mike Sheehan 404-474-1395 info@igt2030.com	<b>Project Number</b>	#0300 :: UIUC Astronomy Building	<b>DATE:</b>	11/19/2021
	<b>BUILDING ID:</b>	1002 W Green St, Urbana, IL 61801	<b>SURVEY</b>	
	<b>FLOOR LEVEL</b>	First	<b>ANALYSIS</b>	
	<b>TEST TYPE:</b>	Dilution 10/20/30/40	<b>VERIFY</b>	



Provide dilution test for airborne pathogen mobility in specific rooms.

**DILUTION TEST SCENARIOS - AIR SAMPLE ONLY**  
 D1 - 112 MEN'S RESTROOM 10/20/30/40 MINUTE INTERVAL  
 D2 - 109 WOMEN'S RESTROOM 10/20/30/40 MINUTE INTERVAL  
 D3 - 134 CLASSROOM 05/10/15/20 MINUTE INTERVAL

<b>IGT Project Manager</b> Mike Sheehan 404-474-1395 info@igt2030.com	<b>Project Number</b>	#0300 - UIUC Astronomy Building	<b>DATE:</b> 11/19/2021
	<b>BUILDING ID:</b>	1002 W Green St, Urbana, IL 61801	<b>SURVEY</b>
	<b>FLOOR LEVEL</b>	Second	<b>ANALYSIS</b>
	<b>TEST TYPE:</b>	Dilution 5/10/15/20	<b>VERIFY</b>



Provide dilution test for airborne pathogen mobility in specific rooms.

- DILUTION TEST SCENARIOS - AIR SAMPLE ONLY**
- D4 - 214 MEN'S RESTROOM 10/20/30/40 MINUTE INTERVAL
  - D5 - 222 BRAKE ROOM 05/10/15/20 MINUTE INTERVAL
  - D6 - SECOND FLOOR CORRIDOR (NO VENTILATION) 05/10/15/20 MINUTE INTERVAL



# Integrating Green Technologies

## FIELD CHARACTERIZATION

UL QUOTE DATE:  
ST QUOTE DATE:

IGT Project Manager	<b>Project Number</b>	#0300 UIUC Astronomy Building	DATE: 11/19/2021
	<b>Client Name :</b>	Morgan White, Associate Dir. of F&S for Sustainability	<b>SURVEY</b>
	<b>Phone:</b>	217-333-2668	<b>ANALYSIS</b>
	<b>Email:</b>	mbwhite@illinois.edu	<b>VERIFY</b>
<b>Building ID:</b> 1002 W Green St, Urbana, IL 61801		<b>Stories:</b> 2	<b>Area:</b> 18,000 S.F. approx

### Building Exterior



Front Elevation

Front Entry Signage

Front Entrance



Classroom 134

Breakroom 222

Unoccupied Office



Typical Office

Radiant heat at Restroom

Restroom Exhaust



Acoustical Tile Ceiling - typical





## 04. SSC Project Budget and Timeline



STUDENT SUSTAINABILITY COMMITTEE



UNIVERSITY OF  
**ILLINOIS**  
URBANA - CHAMPAIGN  
Facilities & Services for Sustainability



## STUDENT SUSTAINABILITY COMMITTEE Step II Application

Please submit this completed application and supporting documentation to Sustainability-Committee@Illinois.edu. The Working Group Chairs will be in contact with you regarding any questions about the application. If you have any questions about the application process, please contact SSC at Sustainability-Committee@illinois.edu.

### GENERAL INFORMATION

<b>Project Title:</b>	Engineering Assessment of HVAC Indoor Air Quality Performance Verification for Energy Efficient Infection Control	
<b>Total Amount Requested from SSC:</b>	\$11,488.00	
<b>Amount Requested as:</b>	GRANT	(LOAN or GRANT)

### SCOPE, SCHEDULE, AND BUDGET VERIFICATION

If the project required you to obtain information from Facilities & Services Planning Division, please include that here and attach any supporting documentation.

#### Scope & Schedule

What is the plan for project implementation? Describe the key steps of the project including the start date, target completion date, target date for submitting a

Task	Timeframe (# of weeks to completion)	Estimated Completion Date
Test Site Floor Plan Analysis, Determine Test Site Design		Completed Thurs Nov 18, 2021
Develop Project Protocols, Establish Sampling Methods		(required for proposal testing protocol and budget)
Identify Sampling Points, Origin Points + Test Intervals	2-weeks	
Materials Procurement, On-site Delivery and QC	1-week	
Set-up, Testing and Chain of Custody Implementation	1-day	TBD (Full Saturday Jan 2022)
Lab Testing and Results	10-days	Within 10-days following Jan 2022 test date
Final Report Writing and Quality Control	1-week	One week after receipt of lab results

#### Budget

List all budget items for which funding is being requested under the appropriate category in the following table. Include cost and total amount for each item

Item	Cost Per Item	Quantity	Total Request
<b>Equipment &amp; Construction Costs</b>			
Spray Nebulizer DNA w/Tag Label TAGGING SYSTEM	\$199.00	16	\$3,184.00
Air Sample Pumps With Batteries AIR SAMPLES	\$110.00	20	\$2,200.00
Extra AAA Batteries 20-ct (3 each pump) ENERGY	\$24.50	2	\$49.00
Filters (Box) LAB MATERIAL	\$70.00	1	\$70.00
Cassettes + Filters LAB MATERIAL	\$25.00	16	\$400.00
Cassette Plugs (Red) Bottoms (BLUE) LAB MATERIAL	\$10.00	16	\$160.00
Ziplock Sample Bags (Large) LAB MATERIAL	\$20.00	1	\$20.00
Plastic Weigh Boat LAB MATERIAL	\$25.00	1	\$25.00
Cotton Swab 100-ct LAB MATERIAL	\$15.00	1	\$15.00
Clean Floor Plans (on paper) PRINTED MATERIALS	\$2.00	1	\$2.00
Annotated Plans (on paper) PRINTED MATERIALS	\$2.00	1	\$2.00
Data Collection Form PRINTED MATERIALS	\$2.00	1	\$2.00
Materials and Equipment Checklist PRINTED MATERIALS	\$2.00	1	\$2.00
QC Checklist PRINTED MATERIALS	\$2.00	1	\$2.00
Chain of Custody Form PRINTED MATERIALS	\$2.00	1	\$2.00
Origin Point Labels PRINTED MATERIALS	\$10.00	1	\$10.00
Sample Number Labels PRINTED MATERIALS	\$20.00	1	\$20.00
Extra Set Of OP/SP/SN Labels PRINTED MATERIALS	\$20.00	1	\$20.00
Face Masks SAFETY PPE	\$30.00	1	\$30.00
Lab Test Results	\$1,050.00	1	\$1,050.00
Subtotal			\$7,265.00

#### Publicity & Communication

Ongoing Indoor Air Quality Data Monitor w/App and Cloud-Connected Dashboard	\$399.00	1	\$399.00
			\$0.00
			\$0.00
			\$0.00
			\$0.00
			\$0.00
			\$0.00
			\$0.00
			\$0.00
			\$0.00
Subtotal			\$399.00





## **05: SafeTraces Technology Whitepaper and Safety Data Sheet**



STUDENT SUSTAINABILITY COMMITTEE



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Facilities & Services for Sustainability

# veriDART™

## Assessing Engineering & HVAC Systems for Infection Control

The veriDART™ Solution for the Built Environment



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## About SafeTraces

SafeTraces is deeply committed to the mission of ensuring the highest safety standards for the food we eat, the medication we take, and the air we breathe. Now more than ever, people demand transparency and assurances from food companies, drug manufacturers, and property managers regarding their safety practices. Harnessing the power of DNA, SafeTraces has developed groundbreaking solutions for food and drug traceability, sanitation verification, and safe airflow verification that address our fundamental human need for safety. We work tirelessly in support of our customers to advance the cause of making a better, safer world.

SafeTraces was founded in 2015 and has grown into an expert team of entrepreneurs, scientists, and engineers dedicated to using nature's own DNA to make the world a safer and better place.

## Disclaimer of Liability

This white paper provides general information and opinions; it is not intended for use as consultation. While every effort has been made to ensure the accuracy and reliability of information contained herein, SafeTraces, Inc. and the author disclaim any and all liability to any party for any loss, damage, or disruption caused by errors, omissions, or inaccuracies in the white paper regardless of the cause. By using this document, you accept this disclaimer in full.

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*“The evidence suggests that mitigating airborne transmission should be at the forefront of our disease-control strategies for COVID-19”<sup>1</sup>*

**Joseph Allen**, Director of Healthy Buildings Program  
at Harvard TH Chan School of Public Health

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## The Challenge

SARS-CoV-2 represents one of the greatest threats to public health and economic livelihoods in the past century, killing over 155,000 Americans, infecting over 4.7 million Americans, and leading to over 30 million US job losses as of early August 2020.

SARS-CoV-2 creates a significant public health and safety risk in the built environment, with leading experts emphasizing the importance of airborne transmission via respiratory droplets that aerosolize, stay suspended in air for hours, and travel significantly beyond six feet. Emerging scientific research is increasingly lending credence to their argument:

- A peer-reviewed study published in Nature on July 29, 2020 by University of Nebraska Medical Center researchers found that aerosols collected in the hospital rooms of SARS-CoV-2 patients contained the live virus.<sup>2</sup>
- A peer-reviewed study published in Building and Environment on June 20, 2020 by University of Hong Kong and Zhejiang University scientists found that “the smaller the exhaled droplets, the more important the short-range airborne route.”<sup>3</sup>
- A pre-print study posted on July 15, 2020 by Harvard University and Illinois Institute of Technology researchers found that “aerosol inhalation was likely the dominant contributor to COVID-19 transmission among passengers aboard the Diamond Princess Cruise Ship.”<sup>4</sup>

In response to the airborne transmission risk, the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) published a position document on infectious aerosols, stating the role of building operations and HVAC systems in infection control:

*“Transmission of SARS-CoV-2 through the air is sufficiently likely that airborne exposure to the virus should be controlled. Changes in building operations, including the operation of heating, ventilating, and air conditioning systems, can reduce airborne exposures.”<sup>5</sup>*

However, practical application of ASHRAE’s guidance is easier said than done given the complexity, urgency, and our evolving understanding of the risk presented by SARS-CoV-2. In many respects, building management for infection control represents a 180-degree contrast with building management under pre-pandemic conditions, with a strong tension between health and safety risk mitigation on the one hand and operational management of engineering systems and cost management of energy inputs on the other hand.

Furthermore, facilities, EHS, and engineering organizations lack adequate diagnostic solutions for assessing the risk of airborne pathogen transmission indoors, operating with insufficient data in the face of a once-in-a-century pandemic, with life-and-death safety consequences and enormous financial cost, risk, and liability at stake.

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## Track Record of Innovation

Since 2015, SafeTraces has been a leader and innovator at the forefront of DNA-based testing solutions for safety, traceability, and environmental monitoring. Spawned from the Lawrence Livermore National Labs, our groundbreaking, patented technology leverages DNA-tagged particles that safely mimic the mobility of airborne pathogens. In its early days, our technology supported biosecurity-focused applications for the Department of Homeland Security and New York City Transit Authority, as well as well as the Department of Defense.

Subsequently, the National Institutes of Health (NIH) has supported SafeTraces with multiple research grants to build on our initial breakthroughs for wider development and application of our technology in food, pharmaceuticals, and the built environment. Additional financial support has been provided by the U.S. Food and Drug Administration (FDA) and National Science Foundation (NSF), and technical advisory support has been provided by a world-class team of multi-disciplinary experts in biochemistry, fluid dynamics, virology, and building science at Stanford University, the Massachusetts Institute of Technology (MIT), and the University of Nebraska.

# Groundbreaking Technology

At the cutting edge of building science, health science, and data science, veriDART™ is the first and only diagnostic solution for safely assessing airborne pathogen risk in the built environment, enabling facility managers to identify hotspots, assess ventilation and filtration, and inform remediations. veriDART's groundbreaking technology mimics the mobility of airborne pathogens in three primary ways:



**1. Chemical Composition:** veriDART's tracers mimic the chemical composition of human saliva and aerosols. Tracers consist of distilled water, food-grade, water-soluble ingredients, and DNA. veriDART adheres to the highest levels of product safety. The FDA confirmed Generally Recognized as Safe (GRAS) status for our technology, which uses short, non-coding, non-living DNA sequences. veriDART complies with OSHA, NIOSH, and ECHA safe exposure limits.



The average vacuum flow rate for the air sampler simulates inhalation

**2. Aerosol Mobility:** veriDART's tracer mobility simulates transmission of airborne pathogens via a spraying action that approximates human coughing and sneezing and an air sampling action that approximates human inhalation. Each spray creates a distribution of tracer particle sizes consistent within human respiratory droplet and aerosol range. Meanwhile, veriDART employs an air sampler with a vacuum flow rate similar to breathing that pulls airborne particles on to a filter specialized for small aerosols. veriDART's secondary sampling method is surface swabs for customers interested in analyzing fomite transmission risk.

**3. Detection Levels:** veriDART's detection levels are informed by infectious viral loads for respiratory droplets and aerosols, with DNA concentrated in tracers based on the latest virology for SARS-CoV-2 and other airborne pathogens. Leveraging polymerase chain reaction (PCR) technology, veriDART measures the difference between the baseline concentration level of DNA copies in each tracer solution and the detection level of each tracer solution found at each sampling point in order to establish a quantifiable reduction on a log<sub>10</sub> scale. This log reduction is the basis for the risk thresholds used in veriDART's heat map visualizations. A 3-log reduction, or 1000-fold decrease, in DNA copies from the baseline to the sampling point is considered the diagnostic indicator for low risk.<sup>6</sup>

DNA Tracer Particles/L		DNA Tracer Reduction Log <sub>10</sub>
10	→	5 (99.999%)
100	→	4 (99.99%)
1,000	→	3 (99.9%)
10,000	→	2 (99%)
100,000	→	1 (90%)
1,000,000	→	0 (0%)

Risk thresholds based on log<sub>10</sub> reduction of DNA copies from control point to sample point

- High Risk (Red): 0-1 log reduction
- Moderate-High Risk (Orange): 1-2 log reduction
- Moderate-Low Risk (Yellow): 2-3 log reduction
- Low Risk (Green): 3 or greater log reduction



## How it Works



*Bullseye visualization shows detection level for each tracer tested at a sample point*



### Plan

SafeTraces develops a comprehensive test plan of an entire building or targeted areas in coordination with the customer's facilities, EHS, and/or engineering teams



### Spray

A test team from SafeTraces or a certified partner releases airborne tracers, each with its own unique DNA identifier, at selected locations defined in the test plan



### Circulate

Airborne tracers disperse over specified time period under representative building occupancy conditions to simulate mobility of infectious aerosols



### Sample

Air and/or surface samples are collected and tested at certified labs using PCR technology



### Report

Within days, SafeTraces delivers a final diagnostic report with heatmap visualizations, in-depth analysis of high-risk areas, potential remediations, and future testing recommendations



### Act

Customer leverages data for critical decisions on space utilization SOPs, HVAC settings, mechanical adjustments, filtration enhancements, and viral inactivation solutions

The customer's final diagnostic report includes the following:

- Summary of high-risk areas identified in testing and potential remediations
- Comprehensive heatmap visualizations and data tables for each HVAC zone, origin point, and sample point that can be tracked over many test cycles

## Targeted Risk Assessment

veriDART is used for targeted risk assessments on top of a survey risk assessment:

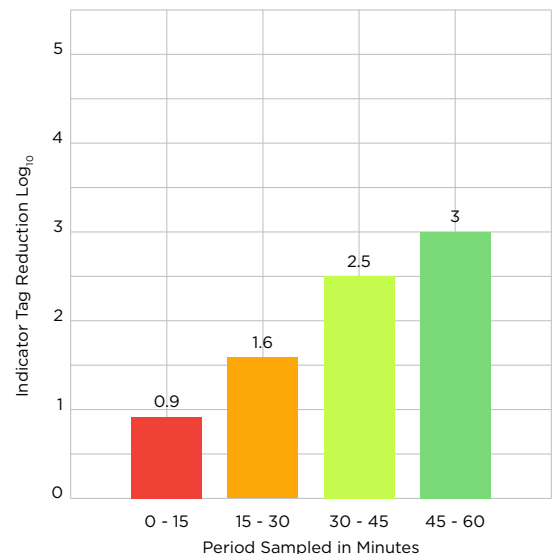
- **Room Recovery:** veriDART measures the time and conditions required to reduce tracer detection to a low risk level (i.e., 3-log reduction or greater) in a specific room or area. This test is particularly

## Applications

veriDART is intended for both pre-emptive risk mitigation (e.g., office re-openings) and post-viral outbreak response (e.g., correctional facilities, meatpacking plants, nursing homes) through two main categories of risk assessments.

## Survey Risk Assessment

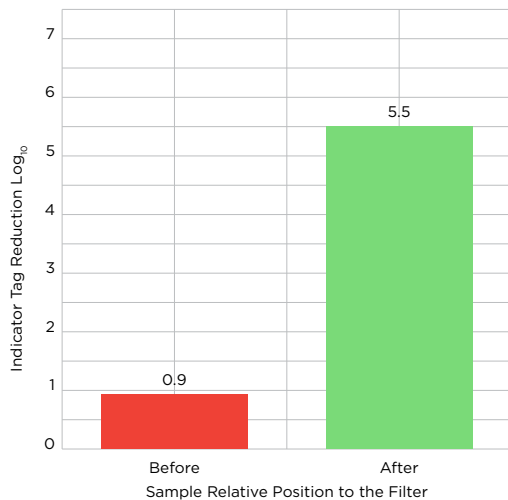
SafeTraces conducts a survey risk assessment of an entire building in order to identify hotspots, assess ventilation and filtration, verify area isolative efficacy, and inform remediations. In coordination with the customer's facilities, EHS, and engineering teams, SafeTraces develops a test plan based on the building size, floor plan, HVAC system configuration, and points of interest and concern, such as restrooms, conference rooms, hallways, elevators, etc. Additionally, SafeTraces develops a test scenario based on a specific set of realistic and representative conditions within the customer's building.



*Room recovery test establishes time and conditions required to reduce tracer to low risk detection level for restrooms, conference rooms, and other high-risk areas*

valuable for assessing the risk of indoor spaces with high-risk factors, including enclosed areas, poorly ventilated areas, high density occupancy areas, and high-trafficked areas. Examples include restrooms, conference rooms, elevators, lobbies, etc. Data informs decisions on space utilization, ventilation, filtration, and airborne disinfecting solutions (e.g., UVGI, bipolar ionization).

- **HVAC Settings:** veriDART measures the impact of HVAC settings on tracer reduction to a low risk level (i.e., 3-log reduction or greater) in a defined room or area. This test is particularly valuable for analyzing the impact of air changes, airflow, outside air, and positive and negative pressurization for infection control. Data informs audits of existing ventilation systems and decisions on HVAC setting adjustments.
- **Filtration:** veriDART measures the impact of filtration level on tracer reduction to a low risk level (i.e., 3-log reduction or greater). This test is particularly valuable for analyzing the impact of different MERV filter levels, including portable HEPA filters, for infection control. Data informs audits of existing filtration systems and decisions on filtration enhancements.



*Filtration test baselines existing system performance and informs enhancement decisions*

veriDART is used as part of two standard models of engagement with customers:

- **Pre- and Post-Remediation Testing:** veriDART provides a baseline risk assessment to inform remediations, followed by a post-remediation risk assessment to evaluate the efficacy of the remediations taken.

- **Regular Environmental Monitoring:** veriDART provides on-going risk assessments, either on a time- (e.g., monthly, quarterly, seasonally) or condition-based (e.g., HVAC system seasonal rebalance or linked to a phased reopening plan) schedule in order to capture the indoor space's changing risk profile and to collect longitudinal data to track performance over time and support healthy building programs.

While veriDART can benefit any building and has no technical restrictions with respect to building-type, initial customers of focus include:

- Office buildings
- Retail locations
- Food processing plants
- Manufacturing plants
- Healthcare and long-term care facilities
- Education and higher education facilities
- Hotels and hospitality facilities
- Correctional facilities
- Sports and physical fitness facilities
- Entertainment production studios and sets

## Customer Return on Investment

veriDART delivers real, quantifiable value to customers in the following ways:

- **Health, Safety, Productivity Protection:** The health and economic impacts of SARS-CoV-2 have been enormous, ranging from death, hospitalization, absenteeism, job loss, revenue loss, to name but a few. Even for healthy individuals, the inability to access physical spaces due to shelter-in-place orders, company-based restrictions, and/or shutdowns and quarantines have had a significant impact on organizational productivity. veriDART is a valuable solution for ensuring proper engineering controls in order to protect occupant health and safety while minimizing disruptions to building and business operations.
- **Liability Protection:** As of late July 2020, 69 employment and labor cases have been filed in the US, contending that workers were exposed or potentially exposed to the virus, with the likes of Walmart, Safeway, and several healthcare facilities facing lawsuits for gross negligence or wrongful death. veriDART is a valuable solution for mitigating

underlying health and safety risk that gives rise to these conditions and for providing empirical data to justify facility, EHS, and engineering remediations undertaken.

- **Capex/Opex Management:** SARS-CoV-2-related mitigation expenditures, including virus-related testing, personal protective equipment, and expanded cleaning and sanitization protocols, have already reached billions of dollars for multinationals like Target, Walmart, and Kroger. With an overwhelming number of different remediations available and infection control projected to significantly impact building operations for at least one to two years if not longer, veriDART is a valuable solution for targeting expenditures to the highest value remediations and enabling property owners and operators to develop a sustainable financial plan.
- **Asset Value Protection:** Analyst Josh Barro states, “There are [real estate] disruptions on two time horizons. In the short term: Unpaid rents and vacant spaces mean financial losses for building owners as the crisis continues; in the long term, if the crisis changes certain real-estate usage patterns for good, it could lead to permanent reductions in the value of certain kinds of real estate, especially commercial real estate, even after society gets back to normal.”<sup>7</sup> veriDART is a valuable solution for mitigating financial

downside risk by ensuring the highest health and safety conditions in buildings to support a return to regular occupancy levels and maximizing financial upside potential by making health and safety a source of competitive advantage for retrofits and new building designs.

- **Peace of Mind:** The pandemic has forced many property owners and operators to proactively communicate the health and safety of their buildings as never before in a way that is critical to their very survival. veriDART is a valuable solution for crisis communications in demonstrating their commitment to building health and safety mitigations undertaken in order to instill public trust and confidence in buildings for safe occupancy.

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**Contact SafeTraces at [info@safetraces.com](mailto:info@safetraces.com) to learn more, get a price quote, and help your occupants breathe easier in the time of COVID-19.**

## References

<sup>1</sup> <https://www.washingtonpost.com/opinions/2020/05/26/key-stopping-covid-19-addressing-airborne-transmission>

<sup>2</sup> <https://www.nature.com/articles/s41598-020-69286-3>

<sup>3</sup> <https://www.sciencedirect.com/science/article/abs/pii/S0360132320302183?via%3Dihub>

<sup>4</sup> <https://www.medrxiv.org/content/10.1101/2020.07.13.20153049v1>

<sup>5</sup> [https://www.ashrae.org/file%20library/about/position%20documents/pd\\_infectiousaerosols\\_2020.pdf](https://www.ashrae.org/file%20library/about/position%20documents/pd_infectiousaerosols_2020.pdf)

<sup>6</sup> <https://academic.oup.com/cid/advance-article/doi/10.1093/cid/ciaa638/5842165> provides evidence supporting median value of 1,780 viral copies for SARS-CoV-2

<sup>7</sup> <https://nymag.com/intelligencer/2020/07/coronavirus-possible-permanent-effect-on-retail-real-estate.html>

*We are continuing to test and improve our veriDART platform as the industry learns more about the SARS-CoV pathogens and aerosol infection processes. Please check periodically for updates to this white paper, review updates on our website, or contact us to learn about our improving SARS-CoV understanding and solutions. veriDART is and will remain at the forefront of pathogen detection, and can be part of an effective strategy to minimize or eliminate the risk of large-scale SARS-CoV pathogen dispersion and infection.*

## Contact

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CA 94588

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## Our Solutions

### veriDART™

By simulating the movement of airborne pathogens in indoor spaces, the veriDART™ proprietary airborne tracers allow the user to verify safe airflow and effective air filtration, and create targeted remediation plans. The veriDART is NIOSH, OSHA, and ECHA compliant and can safely be deployed in any built environment.

### miniDART™

The world's most advanced traceability solution, the miniDART™ applies DNA-based barcodes directly on the product, not the packaging. It enables producers to provide the highest level of assurance for the authenticity, origin, and safety of products ranging from fresh produce, grains, oils, to pharmaceuticals and nutraceuticals.

### saniDART™

A groundbreaking new way to verify cleaning and sanitation effectiveness. The saniDART™ solution provides results that directly correlate to pathogen removal on food contact and non-food contact surfaces in minutes to correct hygiene problems in real-time.



## SAFETY DATA SHEET

This product is NOT considered a hazardous chemical for purposes of the OSHA Hazard Communication Standard, 29 CFR 1910.1200.

### Section 1: Product and Company Identification

#### 1.1 Product Identifiers

**Product Name:** veriDART™

#### 1.2 Recommended Use of the Chemical and Restrictions of Use

**Identified Uses:** tracing agent for aerosol mobility testing inside closed structures such as offices, hospitals, and food processing plants

#### 1.3 Details of the Supplier of the Chemical

**Company:** SafeTraces

**Address:** 4473 Willow Road, Suite 260  
Pleasanton, CA 94588

**Telephone:** +1-925-326-1200

#### 1.4 Emergency Telephone Number: In emergency, call 911.

### Section 2: Hazard(s) Identification

#### 2.1 Classification of the Mixture

**Hazard Classification:** This product is not considered a hazardous chemical for purposes of the OSHA Hazard Communication Standard, 29 CFR 1910.1200 or any state plan counterparts.

#### 2.2 Label Elements

None required or applicable because not considered a hazardous chemical.

**Description of Hazards Not Otherwise Classified:** None Identified.

### Section 3: Composition/ Information on Ingredients

Chemical Name	Synonym	CAS#	Conc.
Distilled Water	Water, Deionized Water	7732-18-5	>95%
Deoxyribonucleic Acid	DNA oligo	9007-49-2	Trade Secret
Preservatives	Preservatives	590-00-1	< 1%

### Section 4: First-Aid Measures

#### 4.1 Description of First Aid Measures

**General Advice:** No need for first aid is anticipated. If unanticipated symptoms arise, consult a physician and show this safety data sheet to the doctor in attendance.

**After Skin Contact:** Wash off with soap and plenty of water. Consult a physician if irritation or other unanticipated symptoms arise.

**After Eye Contact:** Rinse thoroughly with plenty of water for at least 15 minutes. Consult a physician if irritation or other unanticipated symptoms arise. .

**After Inhalation:** If irritation or other unanticipated symptoms arise, move person into fresh air and consult a physician. If not breathing, give artificial respiration.

**After Swallowing:** DO NOT induce vomiting. Never give anything by mouth to an unconscious person. Rinse with water. Consult a physician if stomach discomfort or other unanticipated symptoms arise.

#### 4.2 Most important Symptoms and Effects, Both Acute and Delayed

None known.

4.3 Indication of any Immediate Medical Attention and Special Treatment Needed: None known.

4.4 Note to Physicians: Treat symptomatically and supportively.

### Section 5: Fire-Fighting Measures

#### 5.1 Suitable Extinguishing Media

This product is greater than 95% water and not combustible.

#### 5.2 Special Hazards arising from the Substance or Mixture

Carbon Oxides

#### 5.3 Protective Equipment and Precautions for Firefighters

Whatever would be required by surrounding conditions.

#### 5.3 NFPA

Health: 0 Flammability: 0 Reactivity: 0 Physical Hazards: N/A

#### 5.4 Further Information

No data available.

### Section 6: Accidental Release Measures

#### 6.1 Personal Precautions, Protective Equipment and Emergency Procedures

Use safety glasses with side shields or chemical goggles when using this product. Avoid standing in or breathing spray, vapors, mist or gas.

#### 6.2 Environmental Precautions

Do not let product enter drains.

#### 6.3 Methods and Materials for Containment and Cleaning-Up

Contain spillage, and place in container for disposal according to local regulations.

### Section 7: Handling and Storage

#### 7.1 Precautions for Safe Handling

Do not get into eyes, on skin, or on clothing. When spraying product, hold product away from body and aim spray nozzle away from body (including face) and other personnel. Hold bottle in the location and spray in the direction specified in the test plan. Squeeze the trigger and hold until the spray completes. Release trigger. Repeat 10 times.

#### 7.2 Conditions for Safe Storage, Including and Incompatibilities:

Keep container tightly closed in a dry and well-ventilated place.

### Section 8: Exposure Controls/Personal Protection

#### 8.1 Control Parameters

Contains no substances with occupational exposure limit values.

#### 8.2 Exposure Controls

##### Engineering Measures

Ensure adequate ventilation, especially in confined areas.

Ensure that eyewash stations and safety showers are close to the workstation location.

#### **Personal Protective Equipment**

##### **Eye/Face Protection**

Use equipment for eye protection tested and approved under appropriate government standards such as NIOSH (US) or EN 166(EU).

##### **Skin Protection**

Handle in accordance with good industrial hygiene and safety practice. Chemical resistant gloves are recommended to avoid skin contact with this product.

##### **Respiratory Protection**

Respiratory protection is not required.

#### **Control of Environmental Exposure**

Do not let product enter drains.

##### **Hygiene Measures**

Handle in accordance with good industrial hygiene and safety practice.

### **Section 9: Physical and Chemical Properties**

#### **9.1 Information and Chemical Properties**

**Appearance: Form:** Liquid, clear

**Color:** Colorless

**Odor:** Odorless

**Odor Threshold:** No data available

**pH:** No data available

**Melting Point/Freezing Point:** No data available

**Initial Boiling Point/Boiling Range:** No data available

**Flash Point:** No data available

**Evaporation Rate:** No data available

**Flammability (Solid, Gas):** No data available

**Upper/Lower Flammability or Explosive Limits:** No data available

**Auto Ignition Temperature:** No data available

**Vapor Pressure:** No data available

**Vapor Density:** No data available

**Relative Density:** No data available

**Water Solubility:** Completely Soluble

**Partition Coefficient: n=octanol/water:** No data available

**Decomposition Temperature:** No data available

**Viscosity:** No data available

**Explosive Properties:** No data available

**Oxidizing Properties:** No data available

### **Section 10: Stability and Reactivity**

**Reactivity:** No data available

**Chemical Stability:** Stable under recommended storage conditions.

**Possibility of Hazardous Reactions:** No data available

**Conditions to Avoid:** No data available

**Incompatible Materials:** Strong oxidizing agents

**Hazardous Decomposition Products:** No data available

**In the event of fire:** See section 5 (Firefighting Measures).

#### Section 11: Toxicological Information

##### **11.1 No toxicological data available on product.**

**No toxicological data available on product.**

##### **11.2 No evidence of carcinogenicity**

IARC (International Agency for Research on Cancer): No component of this product is identified as probable, possible or confirmed human carcinogen by IARC.

NTP (National Toxicity Program): No component of this product is identified as a known or anticipated carcinogen by NTP.

OSHA (Occupational Safety and Health Administration): No component of this product is on OSHA's list of regulated carcinogens.

ACGIH No component of this product is identified as a known or anticipated carcinogen by ACGIH.

#### Section 12: Ecological Information

##### **12.1 Ecotoxicity: No data available**

##### **12.2 Persistence and Degradability Biodegradability: No data available**

##### **12.3 Bio-accumulative Potential: No data available**

##### **12.4 Mobility in Soil: No data available**

##### **12.5 Results of PBT and vPvB Assessment: No data available**

##### **12.6 Other Adverse Effects: No data available**

#### Section 13: Disposal Considerations

##### **13.1 Waste Treatment Methods**

###### **Product**

Offer surplus and non-recyclable solutions to a licensed disposal company. Contact a licensed professional waste disposal service to dispose of this material.

###### **Contaminated Packaging**

Dispose of as unused product.

#### Section 14: Transport Information

##### **DOT (US)**

Not Dangerous Goods.

##### **IMDG**

Not Dangerous Goods.

##### **IATA**

Not Dangerous Goods.

#### Section 15: Regulatory Information

##### **US Federal Regulations**

###### **SARA 302 Components**

No chemicals in this material are subject to the reporting requirements of SARA Title III, Section 302.

###### **SARA 313 Components**

This material does not contain any chemical components with known CAS numbers that exceed the threshold (De Minimis) reporting levels established by SARA Title III, Section 313.





**SARA 311/312 Hazards**

This chemical does not present any SARA hazards

**Massachusetts Right To-Know Components**

This chemical contains no listed components.

**Pennsylvania Right To-Know Components**

This chemical contains no listed components.

**New Jersey Right To-Know Components**

This chemical contains no listed components.

**California Prop. 65 Components**

This product does not contain any chemicals known to State of California to cause cancer, birth defects, or any other reproductive harm.

**Section 16: Other Information**

**Preparation Information**

SafeTraces, Inc.      Version 1

SDS date of preparation/update: 5/9/2021