Performance Assessment for the Monitoring of Butyl Acrylate and Vinyl Chloride in Air Using Honeywell PIDs

East Palestine Train Derailment

September 8, 2023

Version 1.0.1

Overview

In the first days after the February 3, 2023, Norfolk Southern train derailment in East Palestine, Ohio, many home and business owners in the surrounding Ohio and Pennsylvania areas were evacuated. During the evacuation and after the evacuation order was lifted, air was tested for volatile organic compounds (VOCs) using photoionization detectors (PIDs) as real-time air monitoring screening instruments in conjunction with more accurate and sensitive analytical sampling methods. These PID instruments were used to monitor both worker and community exposure during all phases of the response.

In early March, potential inconsistencies in detecting butyl acrylate with PIDs were observed between manufacturer-provided documentation and in-field instrument performance. These potential inconsistencies were compounded by discrepancies between PID field measurements and those made by the EPA Trace Atmospheric Gas Analyzer (TAGA) mobile laboratory. To investigate further, members of Unified Command began assessing the performance of these PIDs to monitor VOCs in outdoor air in the community as well as in indoor air inside homes and businesses. Specifically, members of Unified Command conducted a rapid field evaluation to determine the PIDs' ability to detect both butyl acrylate and vinyl chloride. However, during this field evaluation, additional questions arose relating to calibration gas mixtures, measurement variation between different instruments and PID models, and whether butyl acrylate would interfere with the detection of vinyl chloride. Following the initial rapid assessment, Unified Command convened a task force to conduct a more thorough assessment of the PIDs used during the response.

PID Task Force Assessment Summary

A multi-organizational task force consisting of members of Unified Command was established along with expert third-party reviewers. The task force evaluated the types of PIDs that have been used on the East Palestine Train Derailment Incident including the two versions of the MultiRAE Pro & AreaRAE Plus/Pro and one version of the ppbRAE. The task force conducted the study during the first week of May 2023. The overall objective of the performance assessment was to evaluate the accuracy and precision of the PIDs. Highlights of the results are as follows:

- Most versions of the PIDs could detect butyl acrylate at 0.2 ppm.
- All versions of the PIDs could detect vinyl chloride at 0.2 ppm.
- The more sensitive (ppb range instrument versions) could also detect vinyl chloride at 0.05 ppm.
- Vinyl chloride detection was not affected by instrument exposure to butyl acrylate.
- Below 0.2 ppm, the accuracy of the instruments was generally lowest.
- Above 1 ppm, the accuracy of the instruments was generally greater.

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1.0 Summary

Following concerns raised regarding the ability of photoionization detectors (PIDs) to detect butyl acrylate, and whether butyl acrylate adversely impacted the ability of these PIDs to detect vinyl chloride, the East Palestine Train Derailment Unified Command convened a task force to assess the performance of these instruments. The instrument evaluation phase of the performance assessment of five Honeywell PID models used during the East Palestine Train Derailment response was conducted between May 1st, 2023, and May 6th, 2023.

Instrument accuracy varied at each target concentration throughout the assessed ranges for both butyl acrylate and vinyl chloride. Accuracy was greatest above concentrations of 1-2 parts-per-million (ppm). The majority of target concentrations that did not meet the data quality objectives of less than 40% relative error* occurred at concentrations at or below 0.2 ppm for both butyl acrylate and vinyl chloride. Several of the used target and calibration gas cylinders were analyzed after completion of the instrument assessments by Enthalpy Analytical and the US Environmental Protection Agency Office of Research and Development (ORD) and their measured concentrations were found to be outside the manufacturer's stated concentration range and/or contain interfering contaminants, particularly for butyl acrylate cylinders. This undoubtedly impacted the accuracy of instrument measurements and calibrations during the assessment. As a result, an attempt was made to correct measurements using analyzed cylinder concentrations. This resulted in an accuracy improvement for 65% of measurements of re-analyzed cylinders. However, not all cylinders used for instrument testing were re-analyzed, and correction after measurement is not ideal as corrections could not be applied to all calibrations and target concentrations. It was not possible to decouple the influences of target and calibration gas cylinder concentrations on the overall instrument measurement accuracy. Furthermore, establishing if instrument inaccuracy was greater at lower concentrations was also problematic as the relative error in target gas and calibration gas cylinder concentration also increased at lower concentrations. The ability to re-derive PID correction factors for butyl acrylate and vinyl chloride for comparison to the manufacturer supplied correction factors was also adversely impacted by these variations in target gas and calibration gas cylinder concentrations.

Due to the confounding factors introduced by target gas and calibration gas cylinder concentration deviations from manufacturer's provided values and chemical contaminants, definitive statements on PID detection capability, particularly at low concentrations, was not appropriate. All Parts-Per-Billion (PPB) model PIDs are considered unlikely or unable to respond (observable increase in measurement) to butyl acrylate concentrations of 0.022 ppm. Due to the uncertainty in the concentration of ethanol contamination in the 0.05 ppm butyl acrylate target gas cylinders, the ability for PIDs to detect 0.05 ppm butyl acrylate cannot be determined. All PPB model PIDs responded to butyl acrylate concentrations greater than or equal to 0.2 ppm as did the AreaRAE Extended Range (ER) PID. Due to a combination of sensor

**Based on US EPA Method TO-15 accuracy requirement of ±30%. An additional ±10% error was permitted as the assessed instrumentation is field survey equipment rather than a laboratory-based analytical method.*

resolution and errors in cylinder concentrations, it was not possible to determine if the MultiRAE (ER) was able to respond to 0.2 ppm butyl acrylate with certainty based on the collected data. The MultiRAE (ER) was able to respond to all target butyl acrylate concentrations greater than 0.2 ppm.

All instruments responded to vinyl chloride at the minimum concentrations of 0.05 ppm for PPB model PIDs and 0.2 ppm for ER model PIDs. However, accuracy was variable and, depending on PID model, did not always achieve the data quality objective for accuracy of ±40% relative error. Following exposure to butyl acrylate, the AreaRAE (PPB) appears to have exhibited decreased response at 0.05 ppm that was not observed with the other assessed PID models. Whether this decrease was directly related to butyl acrylate application or variation in instrument calibration, target gas cylinder concentration, and calibration gas cylinder concentration cannot be determined with certainty as all other instruments continued to clearly respond at all vinyl chloride target concentrations in their range. While some instruments exhibited a decrease in accuracy when measuring vinyl chloride, others exhibited an increase in accuracy. In aggregate, a consistent degradation in instrument ability to measure vinyl chloride following butyl acrylate exposure did not appear to occur.

Ultimately, the assessed PIDs were observed to provide reasonable accuracy as survey grade equipment for vinyl chloride and butyl acrylate at concentrations greater than or equal to approximately 1-2 ppm. The reduced accuracy of measurements as concentration decreases cannot exclusively be attributed to instrument performance as both cylinder concentration accuracy and instrument accuracy tend to decrease simultaneously with target concentration. The proportion of measurement inaccuracy that was due to the assessed instruments rather than error introduced by cylinder concentration inaccuracy and contamination cannot be determined. If the assumption were to be made, despite evidence otherwise, that measurement inaccuracy was due solely to the instrument itself, utility is still maintained. So long as limitations are understood, an inaccurate but discernible response may still indicate the presence of a target chemical.[*] Such measurement responses can be beneficial in protecting the health and safety of workers and the public when deployment of real-time analytical grade equipment is impractical or impossible and when analytical results cannot be delivered in an actionable time frame.

[*] *It is critical to understand in such circumstance, the response of a PID does not necessarily indicate a specific chemical is present as PIDs can respond to a wide array of compounds including hand-sanitizers, perfumes, and other non-hazardous organic and inorganic compounds.*

2.0 Introduction

On February 3, 2023, north of East Taggart Street in East Palestine, Ohio, the derailment of Norfolk Southern Railway Company train 32NB101 resulted in the release of butyl acrylate along with the release, subsequent combustion, and "vent and burn" of vinyl chloride. Following the event, air monitoring began for these compounds by agencies, departments, and companies now associated with the East Palestine Derailment Unified Command using various models of Honeywell RAE Systems[*] instruments equipped with Photoionization Detectors (PIDs)[†], primarily the MultiRAE Pro with extended range and Part-Per-Billion model PIDs (C03-0912-002 & C03-0912-001), ppbRAE (023-3010-001), AreaRAE Plus (C04-0960-000), and AreaRAE Pro (C04-0960-001). The principal users of this equipment were the US Environmental Protection Agency (EPA),[‡] CTEH, and first responders. The monitoring was conducted to protect the public and response worker health and safety throughout the duration of the response and ongoing remediation.

Potential inconsistencies in detecting butyl acrylate were observed between manufacturer-provided documentation and in-field instrument performance. These potential inconsistencies were initially raised following discrepancies between field measurements made by the US EPA Trace Atmospheric Gas Analyzer (TAGA) mobile laboratory equipped with a triple quadrupole mass spectrometer and follow-up measurements using a MultiRAE Pro equipped with Parts-Per-Billion model PID and 10.6 electron volt (eV) lamp. To further explore potential questions of performance, the MultiRAE Pro with Parts-Per-Billion model PID was exposed to 0.05 parts per million (ppm) of butyl acrylate prepared onboard the TAGA mobile laboratory, but the MultiRAE Pro did not provide a response at this concentration. Additional measurements with a different MultiRAE Pro showed similar results. The qualitative identity of butyl acrylate gas delivered to the PID was confirmed by the mass spectrometer onboard the TAGA mobile laboratory.

In a first effort to address the observed discrepancies, CTEH initiated a performance evaluation through acquisition of nitrogen-balanced butyl acrylate calibration gases prepared by Linde Gas and Equipment in concentrations of ~0.5 ppm and ~0.2 ppm. However, Honeywell documentation indicated that nitrogen-balanced calibration gases of less than 1 ppm may not be acceptable for calibration.[1] Additionally, butyl acrylate may undergo self-polymerization as the stabilizer contained in most mixtures, 4-methoxyphenol (MEHQ), requires an oxygen content between 5-21% to function as intended.[2] Despite concerns of self-polymerization, subsequent testing of cylinders by Pace Analytical using Gas Chromatography with Flame Ionization Detector (GC-FID) and Montrose Air Quality Services (MAQS) using Proton Transfer Reaction – Mass Spectrometry (PTR-MS) revealed measured concentrations that were consistent with the certified concentrations of the gas cylinders.

[*] RAE Systems by Honeywell World Headquarters located in Charlotte, NC.
[†] PIDs and lamps are removable and multiple PID models and lamps can be removed and replaced in each instrument.
[‡] Includes The US EPA Superfund Technical Assessment and Response Team sub-contractor which is currently awarded to Tetra Tech.

Following the acquisition of butyl acrylate calibration gas in nitrogen, preliminary performance assessments were conducted by CTEH, US EPA, and US EPA Superfund Technical Assessment and Response Team (START) on PID equipment using butyl acrylate from either purchased gas cylinders or concentrations of butyl acrylate in Tedlar bags prepared onboard the TAGA mobile laboratory. Introduction of butyl acrylate gas to a RAE Systems ppbRAE revealed over-response from the sensor, with measurements approximately 0.1-0.2 ppm greater than the expected butyl acrylate concentrations contained in gas cylinders. MultiRAE Pros with Parts-Per-Billion model and Extended Range model PIDs did not respond as expected, measuring 0 ppm during application of 0.05 ppm (Parts-Per-Billion PID Only) and ~0.2 ppm butyl acrylate (both PID models). Upon application of 0.9155 ppm butyl acrylate from a Tedlar bag sample for both PID models, the measured concentration, with correction factor applied, was approximately 19% less than the target concentration. Application of 0.196 ppm butyl acrylate from gas cylinders resulted in a measurement of 0 ppm on both PID models.[3]

Following the preliminary performance investigation, additional concerns were raised by US EPA and CTEH personnel regarding interference from potential self-polymerization and adhesion of poly (butyl acrylate) to the instrument lamp and filters. Butyl acrylate is known to self-polymerize under ultra-violet (UV) radiation.[2] While UV radiation[4] is produced by PIDs, the low concentrations of butyl acrylate, constant airflow over the lamp, and degradation of compounds on the lamp from ozone production[1] would reduce the probability of this occurring. US EPA expressed further concern that polymerization or adhesion of butyl acrylate could interfere with the instrument's ability to detect vinyl chloride.

As the previously stated work raised questions about the suitability of Honeywell PIDs for the detection of butyl acrylate, the East Palestine Train Derailment Unified Command sought to obtain experimentally determined performance specifications for these PIDs, primarily assessing the manufacturer-published butyl acrylate correction factor* of 1.6[5–7] for RAE Systems PIDs calibrated with isobutylene.

**As these instruments are generally calibrated to isobutylene and not butyl acrylate, a measurement can be multiplied by a correction factor to estimate the concentration of butyl acrylate using the original measurement. This action assumes the measured concentration in air is butyl acrylate only.*

3.0 Chemical Properties for Analyzed Compounds

3.1 Butyl Acrylate

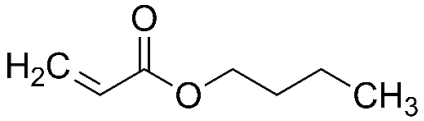
Butyl acrylate (CAS 141-32-2) is a colorless liquid at room temperature, and in the outdoor environment, except for extreme cold (lower than -64°C) conditions. Butyl acrylate is used in the production of many common consumer, construction, and industrial products including arts and crafts adhesives, fingernail adhesives, paints, building materials, printer toner, and caulks/sealants.[8,9]

Several odor thresholds have been reported for butyl acrylate in the range of 0.00029 - 0.101 ppm.[10,11] Analysis of recent scientific literature by US EPA ORD indicates that the odor threshold is at the lower end of the of these ranges.[12–14] The odor characteristic reported for butyl acrylate varies and is described as fruity, musty, plastic, rancid, strong, and/or sweet.[10]

Table 3.1 Butyl Acrylate Physical Properties [8,15]

Synonyms	2-propenoic acid butyl ester
Chemical formula	$C_7H_{12}O_2$
Formal Charge	0
Molecular weight	128.17
CAS Reg. No.	141-32-2
Physical state	liquid
Solubility in water	0.14 g/100 mL at 20°C
Vapor pressure	4.3 mmHg at 20°C
Vapor density (air =1)	4.4
Liquid density (water =1)	0.8986
Melting point	-64°C, approximately
Boiling point	145°C
Auto-ignition	267°C
Conversion factors	1 ppm = 5.24 mg/m^3 at 25°C, 101.3 kPa

Figure 3.1 Butyl Acrylate Chemical Structure



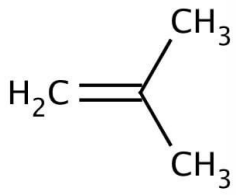
3.2 Isobutylene

Isobutylene is a colorless gas used as a precursor in the production of aviation fuel, resins, plastics, and other chemicals. The odor is described as "faint petroleum-like." While one isobutylene car was involved in the derailment,[16] no release is known to have occurred. Isobutylene has been used during the East Palestine Train Derailment response, and during this assessment, to calibrate air monitoring equipment equipped with PIDs.

Table 3.2 Isobutylene Physical Properties [17,18]

Synonyms	Isobutene, 2-methylpropene
Chemical formula	$CH_2=C(CH_3)_2$
Formal Charge	0
Molecular weight	56.11 g/mol
CAS Reg. No.	115-11-7
Solubility in water	Insoluble
Vapor pressure	2,308 mmHg at 25°C
Vapor Density (air = 1)	1.9
Liquid density (water = 1)	0.59
Melting point	-140.28°C
Boiling point	-6.89°C
Auto-ignition	465°C
Conversion factors	1 ppm = 2.29 mg/m^3 at 25°C, 101.3 kPa

Figure 3.2 Isobutylene Chemical Structure



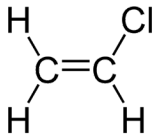
3.3 Vinyl Chloride

Vinyl chloride is a colorless gas at room temperature.[19] The primary use of vinyl chloride is as the precursor monomer for the production of poly vinyl chloride (PVC) through polymerization. The produced PVC is ultimately used in wide array of products including packaging materials, appliances, medical equipment, toys, and other consumer and commercial products.[20] Vinyl chloride has a sweet, pleasant odor with an odor threshold between 203-356 ppm.[10]

Table 3.3 Vinyl Chloride Physical Properties [19,20]

Synonyms	Vinyl chloride monomer, monochlorethene, monochlorethylene, 1-chloroethylene, chlorethylene, chloroethene
Chemical formula	C_2H_3Cl
Formal Charge	0
Molecular weight	62.5 g/mol
CAS Reg. No.	75-01-4
Physical state	Gaseous (room temperature)
Solubility in water	Soluble in almost all organic solvents, slightly soluble in water
Vapor pressure	78 kPa at -20°C 165 kPa at 0°C 333 kPa at 20°C
Liquid density (water =1)	0.9
Melting point	-64°C, approximately
Boiling point	-13.4 at 20°C
Auto-ignition	472°C
Conversion factors	1 ppm = 2.56 mg/m^3 at 25°C, 101.3 kPa

Figure 3.3 Vinyl Chloride Chemical Structure



4.0 Objectives

4.1 Assessment Objectives

The overall objective of the performance assessment was to evaluate the accuracy and precision of the PIDs found in Table 4.1 within the desired ranges of 0.001 – 10.0 ppm of butyl acrylate and vinyl chloride. Equipment to be tested were Honeywell instruments used by Norfolk Southern Railway, CTEH, US EPA/START, and contractors during the East Palestine Derailment response.

Table 4.1 Instruments in Performance Assessment

Instrument name	PID Model name	PID Part Number	Accuracy[21–23]	Measurement Range (ppm)*[21,24]
MultiRAE Pro	MultiRAE Extended Range	C03-0912-002	± 20%	0.1 – 5,000.0
	Parts-Per-Billion	C03-0912-001	± 20%	0.01 – 2,000.00
AreaRAE Plus/Pro	7R+ PID Extended Range	C04-0960-000	± 20%	0.1 – 5,000.0
	7R+ Parts-Per-Billion	C04-0960-001	± 20%	0.01 – 2,000.00
ppbRAE	3GPID+	023-3010-001	± 3%	0.001 – 9,999†

**As isobutylene. The entire measurement range provided by the manufacturer for each PID was not assessed.*

†PID resolution decreases at 10 ppm, 100 ppm, and 1,000 ppm by a factor of 10.

There appears to be no physical or hardware difference between Pro and Plus sub-models of AreaRAEs and MultiRAEs. The ability of Pro sub-models to use the Parts-Per-Billion model PIDs is suspected to be accomplished solely through software differences. Therefore, for the majority of this report, both sub-models of AreaRAEs and MultiRAEs will only be differentiated by the installed PID, i.e., either Extended Range (ER) or Parts-Per-Billion (PPB) PID models.

Testing focused on evaluating performance of the instrument PIDs in a manner that establishes baseline performance without introducing variability from environmental parameters such as temperature and humidity. All data were assessed against the Data Quality Objectives contained in Section 4.2. These tests were performed independently on each of the three PID models listed in Table 4.1.

The main objectives of the PID assessment were:

1. Establish the accuracy and precision of the instrument's measurement of isobutylene when calibrated to isobutylene as this calibration directly impacts measurement of butyl acrylate and vinyl chloride concentrations when applying correction factors.

2. Establish the accuracy and precision of the instrument's measurement of butyl acrylate when calibrated to butyl acrylate to evaluate the suitability of butyl acrylate calibration as an alternative to isobutylene calibration in specific scenarios (e.g., evaluation of TAGA mobile lab detections.)

3. Evaluate the measurement accuracy and precision, along with correction factors, of the instrument for butyl acrylate and vinyl chloride when calibrated to isobutylene. This test was used to identify any degradation in measurement accuracy and precision as a result of multiple applications of butyl acrylate.

4. Establish if exposure of the PID to butyl acrylate degrades the instrument's ability to detect vinyl chloride by determining the accuracy and precision of vinyl chloride measurements following the introduction of butyl acrylate to the instrument.

4.2 Data Quality Objectives and Quality Control

The assessment was observed in its entirety by one or more US EPA ORD staff. ORD staff did not participate directly in conducting the assessment but provided continual advice and feedback during the assessment including recommendations for corrective actions.

Following the end of the field portion of the assessment, cylinders containing isobutylene, vinyl chloride, and butyl acrylate were analyzed by Enthalpy Analytical and EPA ORD using laboratory analytical equipment. These analyses were conducted as gas cylinder concentrations may vary from the manufacturer stated concentration or contain impurities that may result in measurement inaccuracy for the assessed equipment.

Specific QC checks and initial maintenance were performed to help assess the reliability of the data and flag collected data when necessary. These maintenance and QC checks are listed as follows:

Maintenance

- Instrument calibration was performed prior to instrument assessment. Instruments were calibrated following manufacturer guidance contained in equipment manuals.[21–23] No instruments which failed calibration were used to record assessment measurements.

- All instrumentation was updated with the manufacturer's latest firmware prior to the assessment.

- All instrumentation was fitted with new consumable components such as PIDs, lamps, filters,[*] etc., at the start of the assessment. All new PIDs and lamps were manufactured by Honeywell. All maintenance was performed according to the manufacturer's recommendations and method requirements by CTEH or START. The instruments were not new and had been subject to varying degrees of field use prior to the assessment.

QC Checks

- Instrument bump checks were conducted pre- and/or post-test. A bump test is the application of a known concentration of gas to an instrument without conducting calibration to establish whether the instrument continues to measure correctly within the desired accuracy range.

- All tube connections between regulator and instrument inlets were initially checked for apparent leaks, visible damage, or visible contamination which could impact the accuracy of measurements.

- The air flow rate for each instrument was measured prior to assessment of each instrument type. The manufacturer-recommended ranges for assessed instruments are 0.2 liters per minute (L/min) to ≥ 0.45 L/min.[21–23] An upper limit of 0.75 L/min of instrument airflow was used to prevent excessive gas consumption.

To ascertain the accuracy and precision of instruments, measurements were grouped by instrument/PID, assessment, and gas concentration. The appropriate calculations described in Section 5.8 were then conducted for comparison to Data Quality Indicators.

The target performance for all instruments/PIDs, tabulated in Table 4.2, was based on accuracy criteria of 30% and replicate precision of 25% contained in US EPA Method TO-15.[25] The TO-15 accuracy value was selected rather than the instrument accuracies in Table 4.1 as it better represents the combined errors of

[*] *Includes external inlet filter and internal metallic filter. Metallic filters were not replaced for AreaRAEs as the part was unavailable at the time of the assessment.*

the instrument, calibrations, cylinder concentrations, and other factors encountered during field use. As this metric was originally intended for laboratory grade equipment, and not field survey equipment, an additional 10% was added for a combined accuracy metric of ±40% and 5% was added to the precision metric of ±30%. Table 4.3 provides the QC criteria for the air monitoring equipment.

Table 4.2 Data Quality Indicator Goals

Instrument	Completeness*	Accuracy	Precision	Coefficient of Determination (R^2)
All Instruments in Table 4.1	≥ 90%	40%	30%	>0.90

**Based on ≥ 9 measurements per instrument/PID model and gas concentration.*

Table 4.3 QC Criteria for Air Monitoring Equipment

Measurement Parameter	QA/QC Check Procedure	Frequency	Acceptance Criteria	Corrective Action
Zero Calibration/ Target Gas Calibration	Conduct 3-point calibration	At least once per day, between different assessments if needed	Each point measurement within instrument's stated measurement uncertainty (See Table 4.1Table 3.1)	Attempt recalibration, conduct maintenance, or remove from service.
Bump Test	Challenge instrument with zero air and max calibration concentration.	Beginning/End of each day. Between each different assessment.	Each point measurement within instrument's stated measurement uncertainty (See Table 4.1)	Attempt recalibration, conduct maintenance, or remove from service.
Instrument Air Flow Rate	Measure instrument air flow rate with primary flow meter.	Beginning of each day.	0.2 L/min to 0.75 L/min	Replace instrument pump.

5.0 Methods

All equipment testing was conducted at the Centenary United Methodist Church (CUMC) located in East Palestine, Ohio, which was used as the East Palestine Train Derailment Forward Operating Base. All equipment, equipment components, and gases were sourced by CTEH, Enthalpy Analytical, and US EPA START.

Instrument external inlet filters remained in place during all assessments and calibrations and were replaced with a new filter prior to the start of assessments and then once per day thereafter.

Assessments were conducted inside CUMC to minimize impacts from temperature variation. Temperature and relative humidity (Appendix G) were documented during assessments but were not controlled beyond set points for the heating, ventilation, and air-conditioning system established by the building owner. All gas cylinders and equipment were stored in the same location where testing occurred, ensuring there was no appreciable temperature difference between gases and instruments.

5.1 Photoionization Detectors

5.1.1 Operating Principles and Use

A photoionization detector (PID) uses an Ultraviolet (UV) lamp to ionize a molecule when the ionization potential of the molecule is less than the photon energy (in electron volts) of the UV radiation. The result is the ejection of electrons and formation of positively charged ions in the gas phase. The positive ions are measured as an electrical current that is proportional to the concentration of the chemical. The relationship with the produced current and the concentration of a gas or vapor in air can be determined by measuring the PID's electrical response when exposed to known concentrations of a gas or vapor. PIDs are unable to differentiate individual compounds in air when exposed to a mixture of chemicals.

Instruments equipped with Photoionization Detectors (PIDs) offer an easily portable, comparably durable, and simple to use source of actionable information, even at concentration ranges which may be semi-quantitative. Ease of use and portability of these PIDs is particularly advantageous as the instruments can be rapidly deployed and in use within one hour after their arrival at a site. These PIDs have been manufactured in large numbers and are readily available allowing deployment of a hundred or more units at a worksite. The deployment in such large numbers allows for geographic coverage that is difficult or impossible to reproduce with other instrumentation, and despite limitations, can be critical to the protection of the health and safety of both workers and the public following industrial incidents and other environmental disasters.

5.1.2 Other Equipment Considerations

As an alternative to PIDs, air samples may be collected which provide greater accuracy at low concentrations. The equipment used to collect these samples can be portable, often as easy to use, and can be potentially deployed in similar numbers depending on the method (e.g., EPA Method TO-15). Collection of these samples can in some circumstances be completed in less than 15 minutes, but generally requires

several hours, at which time the samples must be sent to an off-site laboratory for analysis. Results of collected samples are not available in real-time and are generally not available for a minimum of 24-48 hours after collection, delaying or limiting available actions when hazardous conditions are discovered.

Semi-portable equipment exists as an alternative to PIDs that can provide results in real-time or near real-time and may or may not offer improved accuracy at low concentrations (e.g., Portable GC-MS, FTIR).[*] The size and durability of these instruments is still sufficient to be shipped by air, allowing arrival on-site in a similar time period as the assessed instruments. However, these instruments tend to be less portable (heavy/bulky), fragile, difficult to use, and require several hours or days after arrival on a worksite before use. Fewer of these instruments have been produced, or are available for use, precluding deployment in large numbers and coverage over large geographic areas.

Mobile, vehicle-based, laboratory equipment exists which can provide a high degree of accuracy and precision at low concentrations. As the equipment is permanently mounted within the vehicle and must be driven to a work site, arrival depends on distance and may be as little as a day or up to several days. The instrumentation in the mobile laboratory is much more complex than the assessed PID instruments and must be operated and maintained by skilled scientists as opposed to field technicians. Due to the cost and complexity of these mobile laboratories, few exist, limiting availability for unscheduled work and causing delay in deployment to a worksite. Unlike previously mentioned instrumentation and sampling methods, these mobile laboratories are limited to roads (typically paved), preventing access to many locations where air monitoring is needed. While excellent in targeted applications and support roles, lack of available units and skilled operators combined with the inability to access many areas severely limits the geographic area that can be covered. Deploying sufficient units in a timely manner to protect a downwind community and assess their exposure following an industrial incident is typically infeasible, if not impossible.

The health-based screening levels for both workers and the public may change over the course of a project. In the case of an emergency response, the initial focus is frequently on acute health effects that may occur from exposure to higher concentrations. Eventually the focus transitions to lower concentration screening levels that reflect intermediate and chronic health effects. For this reason, selected equipment, and how it is used, changes throughout a response to meet the accuracy requirements and measurement range needed to compare potential exposure to the appropriate screening-level for the current response phase.

Ultimately, all equipment and sampling methods mentioned have advantages and disadvantages which limit their applications. When engaging in air monitoring over a large geographic area, in a highly dynamic environment, where both immediate action and accuracy are required to protect the health and safety of

[*] *Gas-Chromatography-Mass Spectrometry (GC-MS).*
Fourier Transform Infrared (FTIR).

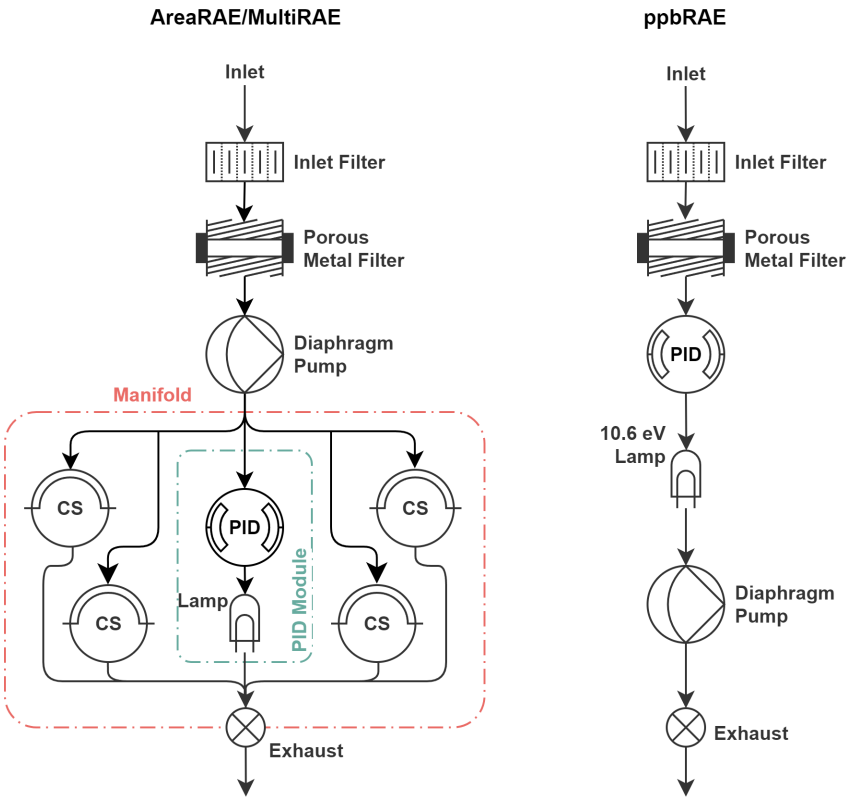
workers, a myriad of equipment is required to supplement the deficiencies of any single component. Even an inaccurate but discernible response on an instrument may indicate the presence of a target chemical. Such responses can be beneficial in protecting the health and safety of workers and the public when deployment of real-time analytical grade equipment is impractical or impossible and when analytical results cannot be delivered in an actionable time frame. It is critical to understand that in such circumstances, the response of a PID does not necessarily indicate a specific chemical is present as PIDs can respond to a wide array of compounds including hand-sanitizers, perfumes, and other non-hazardous organic and inorganic compounds which may bias measurements high. The niche served by the assessed equipment in this holistic approach is leveraging portability, durability, and instrument count to provide exposure monitoring of workers and the public over a wide geographic area along with immediately actionable information in lieu of accuracy. The assessed instruments are not an appropriate substitution for the collection of air samples or analytical laboratory equipment, but the inverse is also true. When the limitations of the assessed instruments are recognized, particularly at lower concentrations, utility is maintained when used to meet an appropriately defined goal. When interpreting instrument responses, actions should be tailored with instrument limitations in mind to provide the greatest advantage.

5.1.3 Assessed Photoionization Detectors

The tested AreaRAEs' and MultiRAEs' sample flow pathways and physical characteristics differ substantially. However, from a conceptual standpoint, the sample flow pathways and component order of the instruments are identical. Once air passes through the AreaRAE and MultiRAE diaphragm pump, it enters a manifold which diverts airflow between the PID and multiple chemical sensors[*] prior to being exhausted from the instrument. The ppbRAE consists of a much simpler flow pathway compared to the MultiRAEs and AreaRAEs as it consists of only a PID. The sample flow pathways and internal component orders are depicted in Figure 5.1, and the exterior of each instrument is depicted in Figure 5.2.

[*] *No chemical sensors were present in any tested instrument. Manufacturer supplied blocks were placed in the chemical sensor positions to limit target gas buildup within the empty sensor chambers.*

Figure 5.1 MultiRAE/AreaRAE and ppbRAE Sample Flow Pathways



CS = Chemical Sensor
PID = Photoionization Detector

Of note are several differences in the sample flow path materials, as well as component order, between the three instrument types which may act as sources of potential interference impacting instrument accuracy and precision. Synthetic rubber was present within the sample flow path of both the MultiRAEs and AreaRAEs which may absorb low concentrations of target gases or may off gas following exposure to higher concentrations of target gas. Synthetic rubber was most prevalent in the MultiRAE with a small mixing chamber between the inlet filter and porous metal filter consisting almost completely of synthetic rubber. Additionally, nearly the entire length of tubing within the instrument was constructed of the same synthetic rubber. The AreaRAE limited the use of synthetic rubber, lacked the same inlet mixing chamber as the MultiRAE, and used only small quantities of rubber at certain tubing joints. For both the AreaRAE and MultiRAE, sample airflow passed through the diaphragm pump (which had a synthetic rubber diaphragm) prior to reaching the PID and chemical sensors. In contrast, the sample air collected by the ppbRAE did not come in contact with synthetic rubber in the flow path prior to the sample air reaching the PID, as the sample air did not pass through the pump first. The tubing between the inlet and PID is considerably shorter and straight in the ppbRAE compared to the other instruments. Additional details regarding assessed instruments are located in Appendix A.

Figure 5.2 Assessed Instruments

Left: AreaRAE; Middle: MultiRAE; Right: ppbRAE
Not to scale

Standard practice in the occupational and environmental health and safety field is to calibrate PIDs used for exposure surveys to isobutylene, per manufacturer recommendations. Since the measurement from the PID is dependent on the ionization potential of the substance being measured, correction factors (CF) have been determined for various chemicals for PIDs calibrated to isobutylene. These correction factors are used to convert the measurement from the instrument to a concentration of the target chemical when the PID is calibrated to isobutylene. For example, butyl acrylate has a correction factor of 1.6.[5–7] An AreaRAE measuring 2.0 ppm would equate to 3.2 ppm butyl acrylate assuming butyl acrylate is the only chemical present capable of eliciting a response from the PID. For chemical mixtures, the PID response is dependent on the fraction of chemicals present in the mixture (Equation 5.8).

5.2 Target Gases

Depending on the test type, various concentrations and mixtures of National Institute of Standards and Technology (NIST) traceable gas were supplied to each instrument and PID combination. Certified analytical standards prepared by third-party vendors Linde Gas and Equipment, Portagas,* and Apel-Reimer Environmental were used in this assessment. All gas mixtures used during the assessment were air balanced. Certificates of analysis were maintained for each standard and are available in Appendix B along with an inventory of cylinders used in the assessment. The cylinder gases were dry, removing the impacts of varying or elevated humidity. The following gases listed in Table 5.1 were used during the evaluation.

*Portagas is a subsidiary of Linde Gas and Equipment, Inc.

Table 5.1 Performance Assessment Test Gases

Gas	Supplier	Mfg. Stated Concentration (ppm)	Mfg. Stated Uncertainty*
Ultra-Zero Air	AirGas	-	NA
Isobutylene	Portagas	2.0	± 5%
		10.0	± 5%
		100	± 2%
Butyl Acrylate	Linde	0.0220	± 20%
	Portagas	0.050	± 10%
		0.20	± 10%
		2.0	± 5%
	Apel-Riemer	9.69900	± 5%
Vinyl Chloride	Portagas	0.050	± 10%
		0.20	± 10%
	Apel-Riemer	0.98100	± 5%
		4.93700	± 5%
		9.73600	± 5%

**Uncertainty in test gas concentration expressed as percent expanded uncertainty[26] with a coverage factor of 2 (Equation 5.14).*

Each instrument and/or PID has a defined measurement range and is not able to measure all available gas standard concentrations used during the assessment. For this reason, the concentration ranges contained in Table 5.2 to Table 5.4 were used for testing of each instrument.

Table 5.2 Isobutylene Challenge Concentrations

PID Model Name	Minimum Concentration (ppm)	Mid-Level Concentration (ppm)	Maximum Concentration (ppm)
MultiRAE (ER)	2.0	10.0	100
MultiRAE (PPB)	2.0	10.0	100
AreaRAE (ER)	2.0	10.0	100
AreaRAE (PPB)	2.0	10.0	100
ppbRAE	2.0	10.0	100

ER = Extended Range model PID with measurement resolution of 0.1 ppm.

PPB = Parts-Per-Billion model PID with measurement resolution of 0.01 ppm.

Table 5.3 Butyl Acrylate Test Concentrations

PID Model Name	Minimum Concentration (ppm)	Low-Level Concentration (ppm)	Mid-Level Concentration (ppm)	Upper-Level Concentration (ppm)	Maximum Concentration (ppm)
MultiRAE (ER)	0.20	-	-	2.0	9.69900
MultiRAE (PPB)	0.0220	0.050	0.20	2.0	9.69900
AreaRAE (ER)	0.20	-	-	2.0	9.69900
AreaRAE (PPB)	0.0220	0.050	0.20	2.0	9.69900
ppbRAE	0.0220	0.050	0.20	2.0	9.69900

ER = Extended Range model PID with measurement resolution of 0.1 ppm.

PPB = Parts-Per-Billion model PID with measurement resolution of 0.01 ppm.

Table 5.4 Vinyl Chloride Test Concentrations

PID Model Name	Minimum Concentration (ppm)	Low-Level Concentration (ppm)	Mid-Level Concentration (ppm)	Upper-Level Concentration (ppm)	Maximum Concentration (ppm)
MultiRAE (ER)	0.20	-	1.0	4.93700	9.73600
MultiRAE (PPB)	0.050	0.20	1.0	4.93700	9.73600
AreaRAE (ER)	0.20	-	1.0	4.93700	9.73600
AreaRAE (PPB)	0.050	0.20	1.0	4.93700	9.73600
ppbRAE	0.050	0.20	1.0	4.93700	9.73600

ER = Extended Range model PID with measurement resolution of 0.1 ppm.

PPB = Parts-Per-Billion model PID with measurement resolution of 0.01 ppm.

After the cessation of planned PID activities, a selection of standards used in the testing was analyzed to confirm the target gas concentrations and verify the absence of potentially interfering compounds in the standard cylinders. All standards for the following methods were introduced to analytical instruments via preconcentration.

Vinyl chloride cylinders were analyzed via a modified EPA Method TO-15[25] analysis at Enthalpy Analytical using a gas chromatograph equipped with a mass selective detector (GC/MSD) calibrated to vinyl chloride. Samples were loaded dynamically, directly from the cylinder, in a manner similar to the PID sampling manifold. No additional humidification or dilution of samples was performed.

Isobutylene cylinders were analyzed via a modified EPA Method 18[27] analysis at Enthalpy Analytical. The standard cylinders were introduced directly to a GC with a flame ionization detector (FID) calibrated for isobutylene. The standard cylinders were loaded dynamically, directly from the cylinder in a manner similar to the PID manifold.

Butyl acrylate cylinders were analyzed via EPA Method TO-15/TO-15A analysis by EPA ORD using an Entech 7200 Preconcentrator and Agilent 7890B GC/5977 MSD calibrated for butyl acrylate in Selected Ion Monitoring mode. Sample gas was loaded into 1.4 L Silonite coated stainless steel sampling canisters, pressurized with zero air when additional dilution was required, and analyzed as described in TO-15/TO-

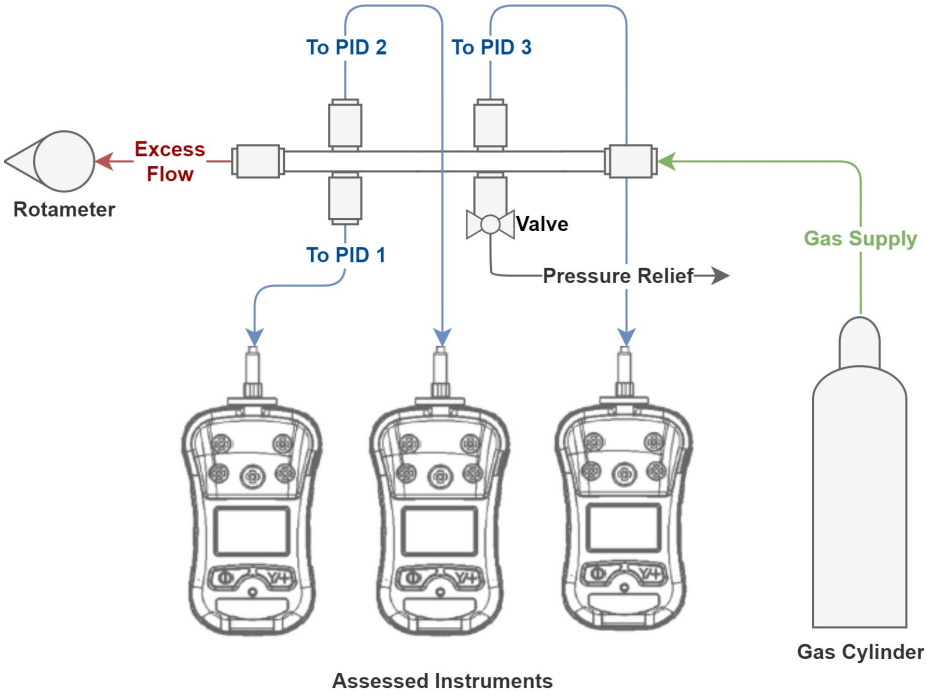
15A. No additional humidification was performed. Butyl acrylate and isobutylene standards were also analyzed at Enthalpy Analytical for identification of potentially interfering compounds.

5.3 PID Assessment Gas Delivery System

Target gas was applied simultaneously to three instruments for each calibration and test using a stainless-steel manifold, stainless steel compression fittings, and constant flow or constant pressure regulator (Figure 5.3). Polytetrafluoroethylene (PTFE) tubing was used for all connections between the instrument pump, manifold, and gas cylinder to minimize contamination of the air stream from tubing material or residual compounds from previous testing events. PTFE tubing was not changed during the assessment.

A fourth run of PTFE tubing from the manifold was present to act as an excess flow relief mechanism allowing the gas flow rate into the instrument to be driven by the instrument's pump at near ambient pressure. The length of the pressure relief tubing was sufficient to prevent backflow into the manifold. A rotameter was present at the terminal end of the relief tubing to ensure excess flow was maintained during testing and calibration. The flow rate of regulators was approximately 1.5 L/min. An excess pressure relief valve was also connected to the manifold and was closed during each assessment.

Figure 5.3 Gas Supply Manifold



5.4 Instrument Calibration Procedures

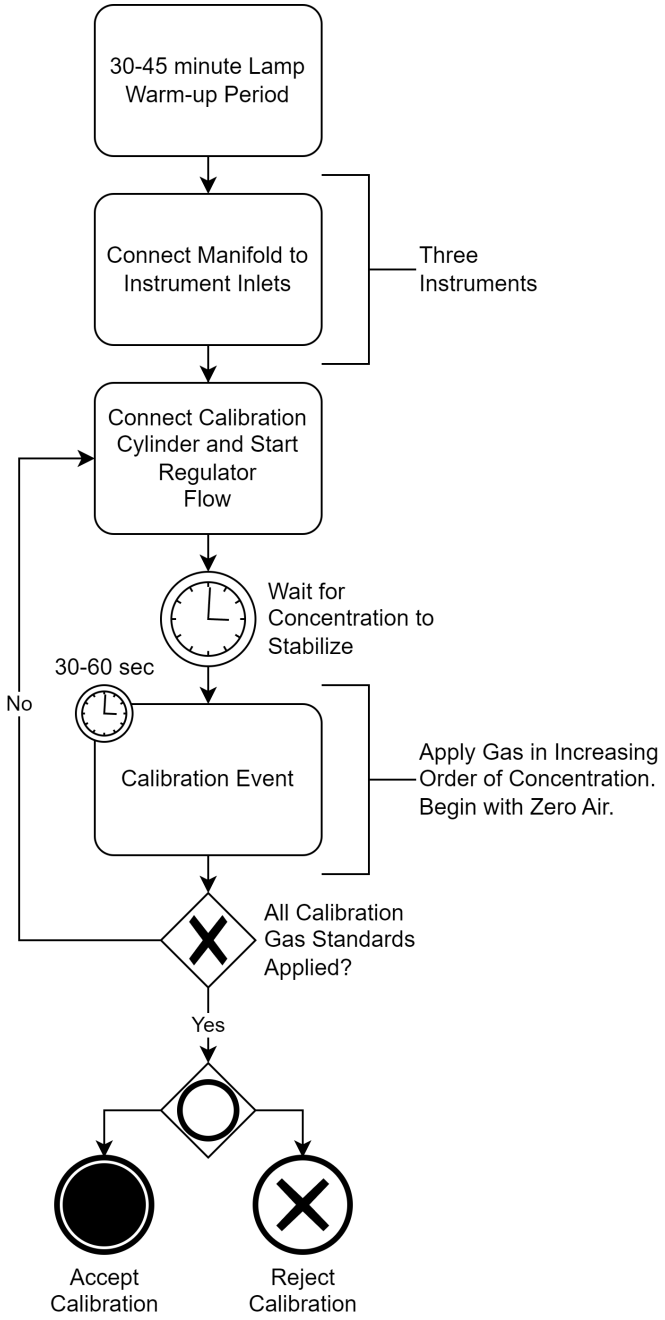
Calibration of each instrument group (Table 4.1) occurred at the beginning of each primary objective test contained in Section 4.1, or at least once per day using the manifold described in Section 5.3. Procedures for calibration followed those contained in instrument manuals[21–23] and technical notes[1,5–7,28,29] for three-

point calibration. The gas concentrations contained in Table 5.5 were used for instrument calibration following the procedure in Figure 5.4.

Table 5.5 Instrument Calibration Concentrations

Gas	Zero Point	Point 2 (ppm)	Point 3 (ppm)
Isobutylene	Ultra Zero Air	2	10
Butyl Acrylate	Ultra Zero Air	2	9.736

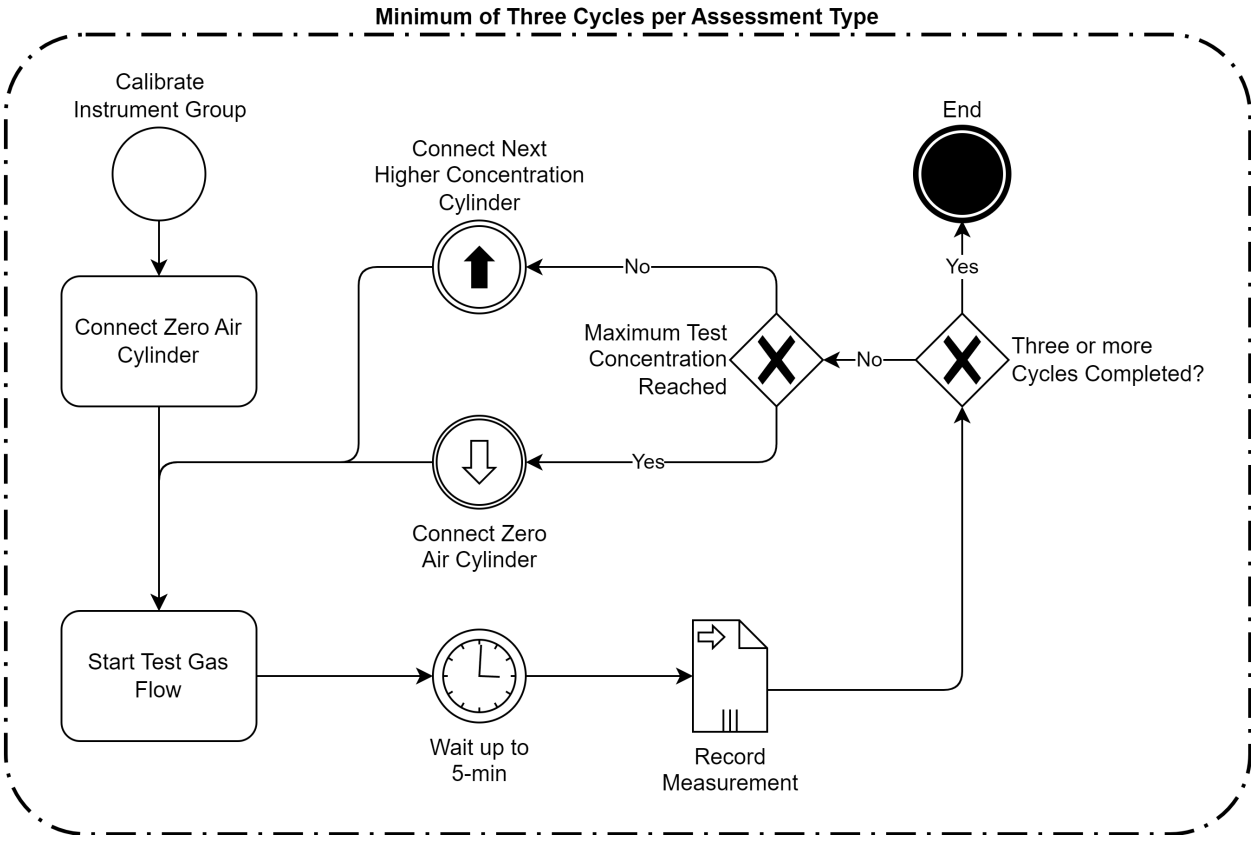
Figure 5.4 General Instrument Calibration Process



5.5 Application of Target Gases

Each gas challenge cycle began with zero air. The lowest target gas concentration was supplied to the instrument group with stepwise increases in gas concentration (Table 5.2 to Table 5.4). Prior to recording the measured concentration, the sensor was permitted to reach a near steady state where the observed measurement remained relatively constant, or if fluctuating, did not have a discernible trend in either the positive or negative direction. A single measurement in ppm was manually recorded at this steady state concentration. The time for the instruments to reach this steady state was generally not allowed to exceed five minutes[*] to conserve test gas. The mean duration target gas was permitted to flow through instruments was approximately 3.3 minutes per target concentration, 19.8 minutes per cycle, and 59.4 minutes per test. Once the maximum test gas concentration was applied, the cycle began again with application of zero-air and continued until a minimum of three cycles were completed for the instrument group (Figure 5.5).[†]

Figure 5.5 Assessment Gas Application Cycle



[*] *On occasion, zero air was permitted to flow through instruments for longer durations between assessments. The longest duration non-zero gas was permitted to flow through an instrument was six minutes and unintentional.*

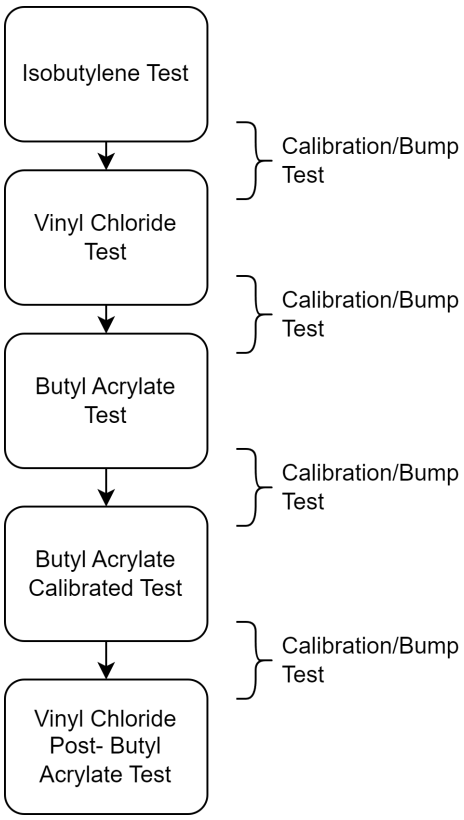
[†] *Additional vinyl chloride test cycles were conducted for the ppbRAE as calibration was not conducted between the isobutylene test and vinyl chloride test.*

An attempt was made to use the same gas cylinders throughout each specific instrument test to minimize variation of measurements between test cycles. However, in some instances it was necessary to exchange cylinders during test cycles due to faulty cylinder valves or rate of gas consumption. This introduced variability as the concentration of contents in each cylinder was not identical.

5.6 Primary Instrument Assessments

All assessments were conducted in an order that minimized potential interference in results from the PID's exposure to butyl acrylate. Assessments requiring only the use of isobutylene and vinyl chloride were conducted first, followed by assessments requiring only the use of isobutylene and butyl acrylate. Testing of potential degradation in the instrument's ability to accurately measure vinyl chloride following PID exposure to butyl acrylate occurred last (Figure 5.6). A minimum of nine measurements were recorded per PID/gas combination listed in Table 5.2 to Table 5.4.

Figure 5.6 General Assessment Order



A bump test is the application of a known concentration of gas to an instrument without conducting calibration to establish whether the instrument continues to measure correctly within the desired accuracy range.

5.6.1 Establishing Instrument Response, Accuracy, and Precision

The instrument response for isobutylene, butyl acrylate, and vinyl chloride gases was determined by challenging each instrument group in the manner described in Section 5.5 using the gas standards in Table 5.1. Each instrument was challenged using the same gas standard via manifold. Calibration and

assessment of butyl acrylate occurred after assessment of isobutylene and vinyl chloride performance in case the physical properties of butyl acrylate interfered with the detection of vinyl chloride. The resulting measurements were used to determine instrument accuracy and precision.

5.6.2 Establishing Instrument Correction Factors

Assessment correction factors for butyl acrylate and vinyl chloride instruments calibrated to isobutylene were determined using least squares linear regression lines for isobutylene, vinyl chloride, and butyl acrylate tests (Equation 5.7). This analysis was conducted using manually recorded data from tests completed in Section 5.6.1 with regression lines constructed from cylinder concentrations (x_i) and the measured concentrations (y_i). Regression line slopes from tests where the instruments were calibrated to butyl acrylate were not compared to the isobutylene regression line slope as the results were not dependent on isobutylene calibration.

5.6.3 Vinyl chloride response after application of butyl acrylate

Each instrument group was calibrated with isobutylene. Butyl acrylate was then supplied to the instrument for a period of approximately five minutes at a concentration of 10 ppm. Vinyl chloride gas was then supplied to the instrument following the procedures in Section 5.5. The difference in performance from previous vinyl chloride testing was then evaluated.

5.7 Additional Data Collection

In general, each instrument was configured to log data in 1-second intervals. However, AreaRAE Pros provided by US EPA START (AR07-AR09) were inadvertently configured to log at 1-minute intervals. These data logs were all downloaded after completion of an individual PID assessment.

At the end of each assessment day, one instrument group was permitted to run overnight (or until battery discharge). In the morning, the instrument group was bump tested with either isobutylene or butyl acrylate depending on the gas the instrument was calibrated to last. The test was conducted to assess the variability in performance following extended use since the last calibration.

During each day of the assessment, room temperature (accuracy ± 0.4°C), barometric pressure (accuracy ± 0.3 hectopascal), and relative humidity (accuracy ± 1.0%) measurements were recorded using a Kestrel Instruments Kestrel 5000 Environmental Meter (Kestrel). The Kestrel is factory-calibrated against NIST traceable standards.[30] These parameters were recorded for observational purposes only, and the impact of these parameters on equipment performance is beyond the scope of this assessment (Appendix G).

The flow rate of instrument pumps was confirmed during the assessment using a Mesa Labs Defender 500 Series NIST traceable primary flow meter. The Defender 500 Series is accurate to within 1% of measured air flow and factory calibrated annually. The flow rate of each instrument's pump cannot be calibrated by the user. Instrument pump performance was compared to QC criteria in Table 4.3 for air monitoring equipment.

Three additional tests were performed other than the primary instrument assessments proposed in the *Performance Assessment Plan for the Monitoring of Butyl Acrylate in Air Using Honeywell PIDs*. These tests were limited in scope and did not occur for all instrument groups and gases. The purpose of these tests was to provide additional information regarding the accuracy of instruments when measuring low concentrations of target gas without the PID having been recently exposed to the maximum target gas concentration. The following additional tests were conducted:

- MultiRAE Pros equipped with Part-Per-Billion PIDs and calibrated to butyl acrylate were tested with three cycles of zero air -> 0.2 ppm butyl acrylate.
- ppbRAEs were two-point calibrated with zero air and 2 ppm isobutylene and tested with three cycles of zero air -> 0.05 ppm butyl acrylate.
- ppbRAEs were two-point calibrated with zero air and 2 ppm isobutylene and tested with three cycles of zero air -> 0.2 ppm butyl acrylate.

5.8 Statistics and Calculations

All statistical calculations were conducted using Python 3 SciPy and NumPy libraries. All statistical calculations were conducted at a confidence level (α) of 0.05 unless stated otherwise. Statistical output can be found in Appendix C.

Linear regression of data generated during this assessment was conducted using least squares regression for each test and instrument group (Equation 5.1). The output of the regression includes intercept ($\hat{b}_0$), slope ($\hat{b}_1$), Standard Error (SE) of the slope, Mean Sum Squares Error (MSE), coefficient of determination (R^2), Confidence Interval (CI) of the regression line, Prediction Interval (PI) of the regression line, and other values as relevant.

Equation 5.1 Linear Least Squares Regression

[a] $$\hat{b}_1 = \frac{\sum_{i=1}^{n}(x_i-\bar{x})(y_i-\bar{y})}{\sum_{i=1}^{n}(x_i-\bar{x})^2}$$

[b] $$\hat{b}_0 = \bar{y} - \hat{b}_1\bar{x}$$

[c] $$\hat{y}_i = \hat{b}_1\hat{x}_i + \hat{b}_0$$

$\hat{b}_1$ = Slope of the linear regression line.
$\hat{b}_0$ = The intercept of the linear regression line.
x_i =The i^{th} independent sample variable.
$\bar{x}$ = The mean of the independent sample variables.
$\hat{x}_i$ = The i^{th} independent predictor variable.
y_i = The i^{th} dependent sample variable.
$\bar{y}$ = The mean of the dependent sample variables.
$\hat{y}_i$ = Predicted dependent variable from the regression line.
n = The sample size.

Confidence intervals describe the interval where the unknown population mean (μ) of the sampled population is expected to fall at confidence level 1-α when re-sampling the population. Similarly, the prediction interval describes the range a future dependent variable may fall for a given independent variable at confidence level 1-α. Confidence and prediction intervals were determined for the sample means ($\bar{x}$) of each gas concentration, instrument group, and test using Equation 5.2a and Equation 5.2b. Confidence and prediction intervals for least squares regression lines were constructed for each test and instrument group using Equation 5.3a to Equation 5.3c.

Equation 5.2 Confidence and Prediction Interval

[a] $$Confidence\ Interval = \bar{x} \pm t_{(\alpha/2),(n-2)} * \frac{S_x}{\sqrt{n}}$$

[b] $$Prediction\ Interval = \bar{x} \pm t_{(\alpha/2),(n-2)} * S_x\sqrt{1+\frac{1}{n}}$$

$\bar{x}$ = The mean of the sample.
t = The critical value of the Student's t distribution at significance level α/2 and n-2 degrees freedom.
S_x = The sample standard deviation.
n = The sample size.

Equation 5.3 Confidence and Prediction Interval of Least Squares Regression (LSR)

[a] $$MSER = \frac{\sum_{i=1}^{n}(y_i - \hat{y}_i)^2}{n-2}$$

[b] $$LSR\ Confidence\ Interval = \hat{y}_i \pm t_{(\alpha/2),(n-2)}\sqrt{MSER\left(\frac{1}{n} + \frac{(\hat{x}_i - \bar{x})^2}{\sum_{i=1}^{n}(x_i - \bar{x})^2}\right)}$$

[c] $$LSR\ Prediction\ Interval = \hat{y}_i \pm t_{(\alpha/2),(n-2)}\sqrt{MSER\left(1 + \frac{1}{n} + \frac{(\hat{x}_i - \bar{x})^2}{\sum_{i=1}^{n}(x_i - \bar{x})^2}\right)}$$

MSER = Mean Sum of Squares Error of the regression line dependent variables.
x_i =The i^{th} independent sample variable.
$\bar{x}$ = The mean of the independent sample variables.
$\hat{x}_i$ = The i^{th} independent predictor variable.
y_i = The i^{th} dependent sample variable.
$\hat{y}_i$ = Predicted dependent variable from the regression line.
n = The sample size.
t = The critical value of the Student's t distribution at significance level α/2 and n-2 degrees freedom.

The one sample *t*-test (Equation 5.4) can be used to evaluate if the sampled population is equivalent to a specified comparison value (μ_0) with a null hypothesis (H_0) of H_0: $\bar{x} = \mu_0$. One-sample *t*-tests were used to assess whether the concentration of target gas measured by instrumentation differed significantly from the concentration of the target gas. If the *t*-score calculated from the one-sample *t*-test was greater than the corresponding critical value from the Student's *t*-distribution at n-2 degrees freedom and confidence level α/2, the null hypothesis (H_0) was rejected.

Equation 5.4 One-sample *t*-test

$$t_{score} = \frac{\bar{x} - \mu_0}{s/\sqrt{n}}$$

$\bar{x}$ = The mean of the sampled population.
μ_0 = The comparison value for the null hypothesis (H_0).
s = The sample standard deviation.
n = The sample size.

Two sample *t*-tests were used to evaluate if the means of two sample sets are equivalent (H_0: $\bar{x}_1 = \bar{x}_2$). This test was conducted to compare vinyl chloride measurements pre and post exposure to butyl acrylate. Welch's *t*-test was performed as the sample sizes (n) were not equal and it was uncertain if the underlying population variances (σ^2) were equal due to PID exposure to butyl acrylate (Equation 5.5). If the *t*-score calculated from the two-sample Welch's *t*-test was greater than the corresponding critical value from the Student's *t*-distribution at the calculated degrees freedom and confidence level α/2, the null hypothesis (H_0) was rejected.

Equation 5.5 Two-sample Welch's *t*-test

$$t_{score} = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}$$

$$df = \frac{\left(\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}\right)^2}{\frac{(s_1^2/n_1)^2}{n_1 - 1} + \frac{(s_2^2/n_2)^2}{n_2 - 1}}$$

$\bar{x}_i$ = The mean of the sampled population.
s_i = The standard deviation of the sample.
n_i = The sample size.
df = Degrees freedom for critical value of t.

The Kolmogorov-Smirnov Goodness-Of-Fit (K-S) test (Equation 5.6) was used to determine if sample data were normally distributed by comparing the empirical cumulative distribution function (ECDF) of the sample to the ECDF of the hypothesized normal distribution constructed using the sample standard deviation (s) and sample mean ($\bar{x}$). Where the corresponding p-value was < α, the null hypothesis (H_0: $F_n(x) = F_0(x)$) was rejected.

Equation 5.6 Kolmogorov-Smirnov Goodness-Of-Fit Test

$$F(x) = \begin{cases} 0, for\ x < y_1 \\ i/n, for\ y_i \le x < y_{i+1} \\ 1, for\ x \ge y_n \end{cases}$$

$$D_n = sup_x[|F_n(x) - F_0(x)|]$$

F(x) = The empirical cumulative distribution function.
$F_n(x)$ = The empirical cumulative distribution function of the sample.
$F_0(x)$ = The empirical cumulative distribution function generated from the hypothesized cumulative distribution function.
y_i = The i^{th} value in the ordered sample set.
n = The sample size.
sup_x = Supremum of the closed interval of the set for $F_n(x)$-$F_0(x)$.
D_n = The Kolmogorov-Smirnov test statistic where H_0: $F_n(x) = F_0(x)$

The experimentally determined correction factor was determined using the ratio of the isobutylene regression line slope ($\hat{b}_{1,iso}$) to the regression line slope of each applicable test ($\hat{b}_{1,g}$) using Equation 5.7.

Equation 5.7 Experimentally Determined Instrument Correction Factor for the Assessment

$$CF_A = {\hat{b}_{1,iso}}/{\hat{b}_{1,g}}$$

$\hat{b}_1$ = Slope of the isobutylene linear regression line.
$\hat{b}_{1,g}$ = Slope of the linear regression line for the gas that the correction factor will be determined for.

Following re-analysis of select cylinders by Enthalpy Analytical and EPA ORD, several cylinders were determined to have contaminants. To determine the manufacturer-recommended correction factor for these mixtures, Equation 5.8 was used.[5]

Equation 5.8 Correction Factor for Mixtures

$$CF_{mix} = \frac{1}{\sum_{i=1}^{n} \frac{X_i}{CF_i}}$$

X_i =The mole fraction of the i^{th} gas in the mixture.
CF_i = The manufacturer correction factor for the i^{th} gas in the mixture.

Measurements recorded from PIDs calibrated to isobutylene (y) can be converted to the concentration of the target gas (C_{fmg}) using Equation 5.9a when the slope of the calibration line is one. If the slope is not one, as in the case when cylinders were analyzed following the assessment, Equation 5.9b may be used.

Equation 5.9 Corrected Measurement Using Manufacturer Correction Factors

[a] $$C_{mfg} = yCF_M$$

[b] $$C_{an} = \frac{(yCF_M - \hat{b}_0)}{\hat{b}_1}$$

$\hat{b}_1$ = Slope of the isobutylene calibration linear regression line using analyzed cylinder concentrations.
$\hat{b}_0$ = The intercept the isobutylene calibration linear regression line using analyzed cylinder concentrations.
y = The concentration measured by the assessed PID when calibrated with isobutylene.
CF_M = The manufacturer's PID correction factor for the target gas.
C_{mfg} = The measured concentration as butyl acrylate or vinyl chloride without correcting the cylinder concentrations.
C_{an} = The measured concentration as butyl acrylate or vinyl chloride after correcting the cylinder concentrations.

Completeness of the dataset was defined as the amount of verified data obtained from the assessment compared to the amount of data that was expected to be obtained (Equation 5.10). Completeness was

assessed by reviewing measurement logs to ensure that all data were verified within the appropriate data quality objectives (DQOs) in Section 4.2.

Equation 5.10 Dataset Completeness

$$\text{Completeness} = \frac{Number\ of\ Verified\ Measurements}{Number\ of\ Expected\ Measurements} \times 100$$

Precision is a measure of mutual agreement among individual measurements of the same property, usually under prescribed similar conditions. Precision was evaluated by making replicate measurements of the same target gas concentration and assessing the variations of the results. Precision for this assessment was defined as the percent relative standard deviation; in other words, the ratio of the sample standard deviation (s) to the mean of instrument measurements ($\bar{x}$) (Equation 5.11). The smaller the resulting percentage, the less variation in the recorded measurements.

Equation 5.11 Precision as Percent Relative Standard Deviation

$$\%\ \text{RSD} = \frac{s}{\bar{x}} \times 100$$

s = Sample standard deviation.
$\bar{x}$ = Mean of instrument measurements.

Accuracy is the degree of agreement of measurements (or an average of measurements) with an accepted reference or true value. Accuracy is a measure of the bias or systematic error in a system. Accuracy of measurement parameters was determined by comparing a measured value (y_i) to the target gas concentration (x_i) and was assessed in terms of relative percent error (Equation 5.12). Negative values indicate a negative bias in the instrument accuracy. Likewise, positive values indicate a positive bias in instrument accuracy.

Equation 5.12 Accuracy as Relative Percent Error

$$\%\ \text{Error} = \frac{y_i - x_i}{x_i} \times 100$$

x_i =The i^{th} independent sample variable.
y_i = The i^{th} dependent sample variable.

Uncertainty in measurements related to instrument and gas standard accuracy can be propagated when assessing instrument performance. Combined uncertainty (u_c) can be determined using Equation 5.13 and when necessary, assumed to be an estimate of the standard deviation.[31] Unless stated otherwise by the manufacturer, instrument and gas cylinder accuracies provided by the manufacturers will be defined as the expanded uncertainty (U_p) in Equation 5.14.[31]

Equation 5.13 Combined Uncertainty

$$u_c = \sqrt{\sum_{i=1}^{n} u_i^2}$$

u_i = The standard uncertainty of the quantity, process, or other value, as standard deviation.

Equation 5.14 Percent Expanded Uncertainty

$$U_p = \frac{k u_c}{X} \text{ x } 100$$

k = Confidence interval coverage factor where 2 = 95% confidence interval and 3 = 99% confidence interval.
u_c = Combined uncertainty.
X = The quantity the combined uncertainty applies to (e.g., instrument measurement, gas concentration in a cylinder.

6.0 Results and Discussion

Data collection completeness achieved the objective of ≥ 90% valid measurements specified in the DQOs with a total of 1,961 manually recorded measurements. A total of four collected measurements were rejected and not included in data analysis due to a faulty pump causing slow gas purge times for AreaRAE Plus instrument AR04. The flow rate of 0.19 L/min for AR04 was below the manufacturer minimum specified range of 0.2 L/min. Therefore, the instrument did not meet the QC criteria contained in Section 4.2 and was replaced. The test cycle was re-conducted with all three instruments. One ppbRAE, instrument, PR01, failed calibration and was replaced prior to recording any test measurements. Data completeness for manually recorded measurements was therefore 100% with at least three manually recorded measurements per test, gas target concentration, and instrument.

Measurements recorded via data logs also met the DQO for completeness of ≥ 90% with a total of 984,845 automatically recorded measurements. One AreaRAE Plus' (AR03) data log was unrecoverable after the assessment due to a hardware or software issue of indeterminate cause. As a result, 15/16 (94%) of instruments used during the assessment have complete and available data logs.

Caution should be used when conducting direct comparison of aggregate performance metrics for vinyl chloride versus butyl acrylate as the assessed measurement range for butyl acrylate was lower (0.022 versus 0.05). This difference can result in a greater percentage of butyl acrylate targets, in aggregate, not achieving performance criteria compared to vinyl chloride. It cannot be determined from this assessment if the instrument performance of vinyl chloride below 0.05 ppm is similar to that of butyl acrylate.

The K-S test (Equation 5.6) was used to identify if data was normally distributed. Out of 109 test/instrument/target concentration groups where the target concentration and variance were not zero, 96.3% were normally distributed at α=0.01, and 91.8% were normally distributed at α=0.05. When it was determined the distribution was not normal at α=0.01, the K-S test was run against 105 alternate distributions, and the distribution with the smallest p-value was selected (Appendix C). As the majority of data groups were normally distributed, it is possible data groups identified as not normally distributed may still be normally distributed if additional data points had been collected.

6.1 Gas Cylinder Re-analysis

Target gas cylinders produced by Portagas were selected throughout the concentration range for re-analysis by Enthalpy Analytical and EPA ORD as these cylinders did not receive final verification of concentration by the manufacturer after dividing the parent cylinder into smaller cylinders. Measured concentrations for 67% of cylinders were outside the uncertainty range specified by the manufacturer in Table 5.1. A summary of these results is contained in Table 6.1.

Table 6.1 Gas Cylinder Re-analysis

Gas Name	Cylinder ID	Detected Compound	Sample Count	Target Conc. (ppm)	Mean Measurement (ppm)	Measurement Range (ppm)	Mean Relative Difference (%)
Vinyl Chloride	V01	Vinyl Chloride	2	0.05	0.05853	0.0494 - 0.0677	17.1
	V06	Vinyl Chloride	4	0.2	0.21321	0.171 - 0.2551	6.605
Isobutylene	IS04	Acetone	1	0	0.00203	NA	NA
		Ethanol	1	0	0.00848	NA	NA
		Isobutylene	1	2	1.94634	NA	-2.7
	IS06	Isobutylene	1	10	8.3989	NA	-16.0
	IS08	Isobutylene	1	10	9.7334	NA	-2.7
	IS10	Acetone	1	0	0.00243	NA	NA
		Ethanol	1	0	0.00515	NA	NA
		Isobutylene	1	2	1.8666	NA	-6.7
Butyl Acrylate	BA01	Butyl Acrylate	2	0.05	0.0216	0.0210 - 0.0222	-56.8
	BA02	Butyl Acrylate	2	0.05	0.02784	0.0274 - 0.0283	-44.3
		Ethanol	3	0	0.23694	0.0816 - 0.3152	NA
	BA03	Butyl Acrylate	1	0.2	0.1563	NA	-21.85
	BA06	Butyl Acrylate	3	0.05	0.01863	0.0126 - 0.0222	-62.74
		Ethanol	3	0	0.26479	0.0658 - 0.3729	NA
	BA10	Butyl Acrylate	1	2	1.9736	NA	-1.32
	BA11	Butyl Acrylate	1	0.2	0.0821	NA	-58.95

Cylinder Contaminant.
Total Cylinder Contaminants > 0.1 ppm.
Cylinder contents not within manufacturer stated uncertainty. See Table 5.1.

While acetone and ethanol contamination were present in some analyzed isobutylene cylinders, the concentrations are not anticipated to adversely impact the assessment. Butyl acrylate cylinders stated by the manufacturer to have 0.05 ppm butyl acrylate were clearly impacted by contaminants along with the low concentration of butyl acrylate. As a result, the correction factors for the analyzed 0.05 ppm butyl acrylate cylinders increased by 392%-501% (Table 6.2a and Table 6.2b) when calculated using Equation 5.8.

Table 6.2 Contaminated Cylinder Correction Factors

(a) Butyl Acrylate Cylinders[5–7]

Cylinder ID	Instrument	Mfg. Butyl Acrylate CF	Mfg. Ethanol CF	Calculated Mixture CF
BA02	AreaRAE	1.60	11.20	6.87
	MultiRAE	1.60	11.00	6.80
	ppbRAE	1.60	7.90	5.59
BA06	AreaRAE	1.60	11.20	8.02
	MultiRAE	1.60	11.00	7.93
	ppbRAE	1.60	7.90	6.27

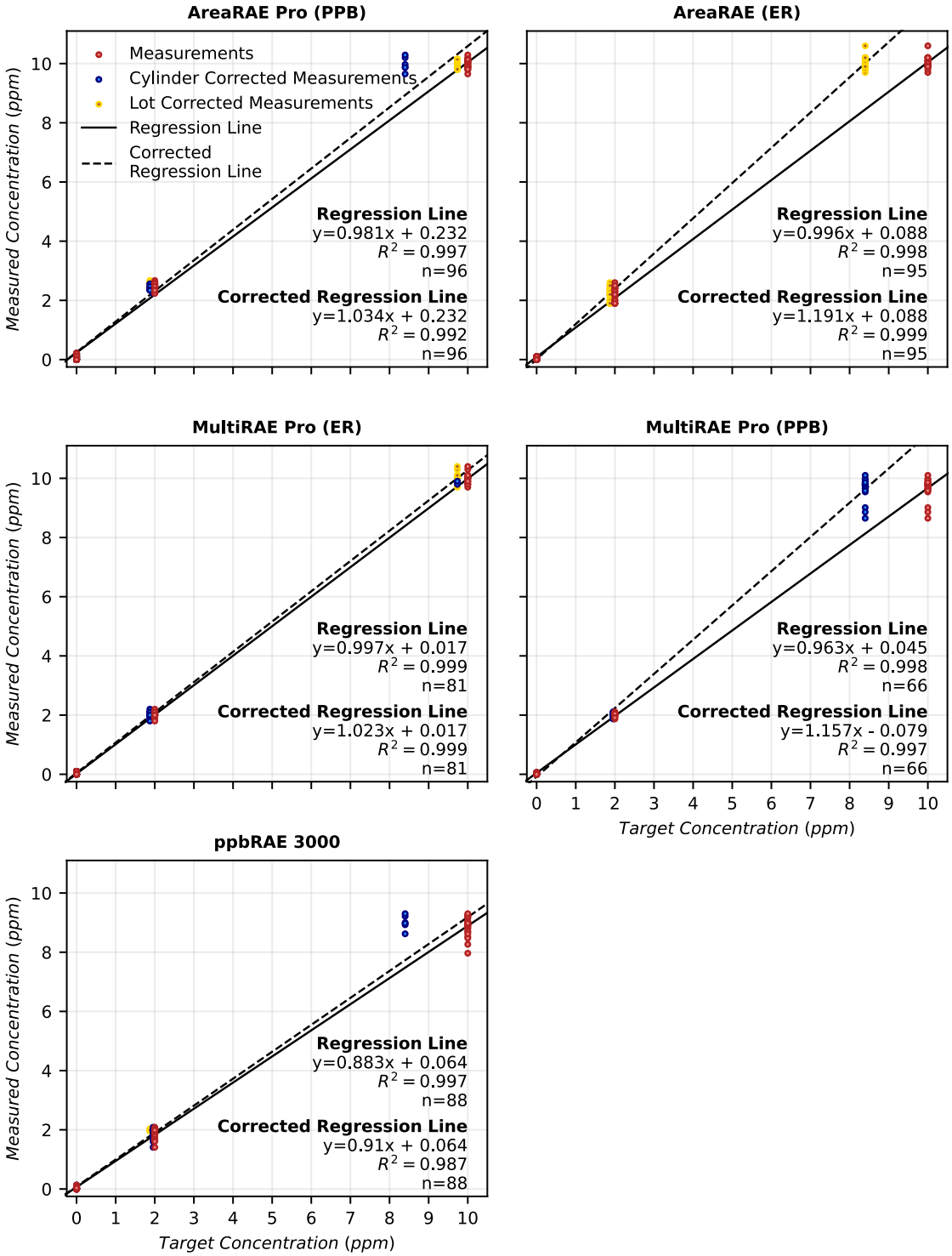
(b) Isobutylene Cylinders[5–7]

Cylinder	Instrument	Mfg. Isobutylene CF	Mfg. Acetone CF	Mfg. Ethanol CF	Calculated Mixture CF
IS04	AreaRAE	1.00	1.08	11.20	1.05
	MultiRAE	1.00	1.08	11.00	1.00
	ppbRAE	1.00	0.90	7.90	1.00
IS10	AreaRAE	1.00	1.08	11.20	1.00
	MultiRAE	1.00	1.08	11.00	1.00
	ppbRAE	1.00	0.90	7.90	1.00

Slopes for the isobutylene calibration line were impacted by lower than anticipated cylinder concentrations. As a result, isobutylene calibration slopes for all instruments increased between 2.6% and 19.6% (Figure 6.1).*

** Cylinders which were not analyzed, but were from the same lot as analyzed cylinders, were assumed to contain the same concentration of isobutylene as analyzed cylinders. All other isobutylene cylinders were assumed to contain the manufacturer's stated concentration.*

Figure 6.1 Isobutylene Calibration Slope Change Due to Cylinder Re-Analysis

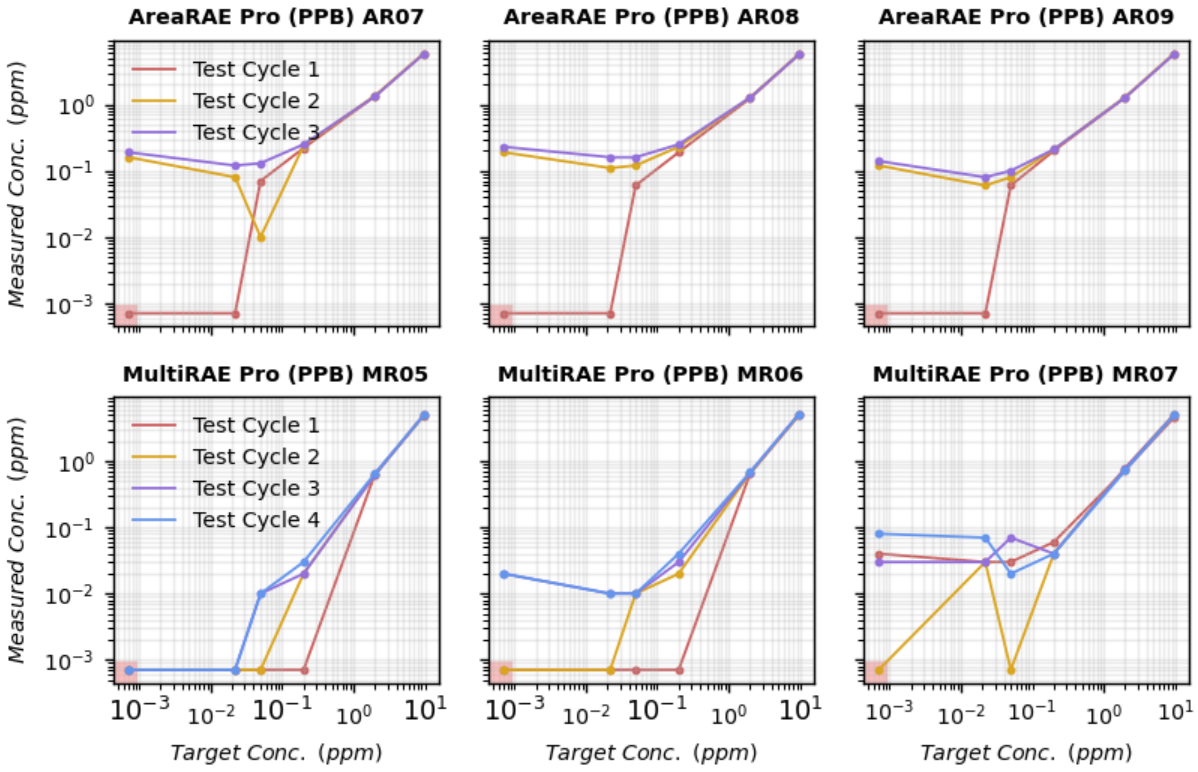


The regression line is constructed using the manufacturer's stated cylinder concentration. The corrected regression line uses cylinder concentrations from re-analysis (blue) by Enthalpy Analytical and the EPA ORD. Cylinders which were not analyzed but were from the same lot as analyzed cylinders (gold), were assumed to contain the same concentration of isobutylene as analyzed cylinders. All other isobutylene cylinders were assumed to contain the manufacturer's stated concentration (red).

6.2 Instrument Precision

For the 103 tests, target gas concentrations, and instrument combinations, 26% were greater than the specified DQO of ≤ 30% for precision as Percent Relative Standard Deviation (%RSD). Precision improved for all tests and instruments at higher concentrations, with all concentrations greater than 0.2 ppm meeting the objective for variation in repeated measurements of ≤ 30%. The reduction in precision at lower concentrations is evident when reviewing graphs of target concentrations versus measured concentrations by test cycle as in example Figure 6.2 where a log scale has been used to view this variability more clearly. Test cycle graphs for all instruments, tests, and target chemicals can be found in Appendix D. Due to the inability to display the logarithm of zero values, all zero values on the x-axis and y-axis have been substituted with $0.001/\sqrt{2}$ where 0.001 ppm is the minimum resolution of the ppbRAE PID. This substitution allows for display of the variability at the zero point of the test cycles, but not without introducing its own inaccuracies.

Figure 6.2 Butyl Acrylate Test Cycles for AreaRAE and MultiRAE PPB PIDs



All zero values on the x-axis and y-axis substituted with $0.001/\sqrt{2}$ to accommodate the log scale. Points within the bounds of the red box in the lower left corner should be considered equivalent to zero response.

Table 6.3 Test Precision as Percent Relative Standard Deviation

			Instrument Model				
Target Gas	**Test Name**	**Target Conc. (ppm)***	**AreaRAE (ER)**	**AreaRAE (PPB)**	**MultiRAE (ER)**	**MultiRAE (PPB)**	**ppbRAE**
Butyl Acrylate	Butyl Acrylate Test	0.022	BR	86.00%	BR	143.50%	75.70%
		0.05	BR	51.20%	BR	139.40%	47.10%
		0.2	28.50%	9.80%	56.70%	61.70%	23.60%
		2	17.40%	2.90%	7.10%	8.40%	4.70%
		9.699	14.20%	1.40%	3.80%	3.30%	0.50%
	Butyl Acrylate Calibrated Test	0.022	BR	27.00%	BR	72.50%	150.40%
		0.05	BR	16.40%	BR	55.70%	99.00%
		0.2	15.80%	13.20%	35.40%	41.00%	21.20%
		2	4.10%	3.30%	1.70%	2.40%	2.70%
		9.699	0.50%	1.50%	2.00%	1.80%	2.10%
Isobutylene	Isobutylene Test	2	9.90%	4.50%	3.60%	2.90%	8.60%
		10	1.80%	1.40%	1.70%	3.60%	3.60%
		100	6.70%	2.10%	5.40%	9.90%	9.50%
Vinyl Chloride	Vinyl Chloride Test	0.05	BR	39.30%	BR	132.30%	84.80%
		0.2	85.70%	24.50%	0.00%	45.30%	65.50%
		0.981	17.30%	10.80%	0.00%	9.50%	40.30%
		4.937	15.60%	2.70%	0.00%	6.70%	9.20%
		9.736	13.60%	2.10%	1.10%	3.00%	5.00%
	Vinyl Chloride Post BA Exposure	0.05	BR	87.90%	BR	56.00%	55.30%
		0.2	24.80%	30.30%	30.00%	40.40%	23.70%
		0.981	16.20%	7.60%	8.40%	8.30%	2.70%
		4.937	14.80%	3.40%	0.00%	3.90%	0.90%
		9.736	11.50%	3.10%	1.50%	2.30%	0.90%

BR = Below PID measurement range.

**Manufacturer stated concentration.*

≤ 30% of x̄ **> 30% of x̄**

For gas concentrations at the lower end of the measurement range, the general trend was an increase in concentration with each cycle, particularly with butyl acrylate. However, it was not uncommon, mostly for vinyl chloride, for measured concentrations on the third test cycle to be below those of test cycles one and two (Appendix D). The cause of the non-linearity at target concentrations less than 0.2 ppm is indeterminate and may be related to a combination of factors including the experimental design, the instruments themselves, and cylinder contents. Trends of increasing concentration per test cycle suggest some degree of residual target gas remains within the gas distribution manifold and/or the instruments themselves resulting in an elevated zero point. Additional caution should be used when drawing conclusions from this assessment about instrument precision in this measurement range due to the additional uncertainties regarding cause.

6.3 Instrument Accuracy

Accuracy of measurements by instrument and target concentration were assessed as mean relative percent error and are contained in Table 6.4. For all instruments, variations in accuracy were clearly apparent

between PID model, substance, and concentration. Measurements were adjusted using the manufacturer's specified correction factors (butyl acrylate CF 1.6; vinyl chloride CF 2.0) for comparison to the DQO for accuracy of ± 40% relative error around the manufacturer-stated target concentration. Both positive and negative biases were observed across the measurement range for all three target gases. Of the 1,183* measurements manually recorded during the primary assessments; 511 measurements (44%) were not within the ± 40% relative error range. Likewise, 23% of the means for each test concentration and instrument combination did not meet ± 40% relative error range (Table 6.4). Mean relative error in ppm is contained in Table 6.5.

Table 6.4 Test Accuracy as Mean Relative Percent Error

			Instrument Model				
Target Gas	**Test Name**	**Target Conc. (ppm)***	**AreaRAE (ER)**	**AreaRAE (PPB)**	**MultiRAE (ER)**	**MultiRAE (PPB)**	**ppbRAE**
Butyl Acrylate	Butyl Acrylate Test	0.022	BR	392.9%	BR	9.1%	353.9%
		0.05	BR	180.9%	BR	-54.7%	151.2%
		0.2	68.9%	77.8%	-37.8%	-77.3%	39.3%
		2	-17.3%	3.7%	-40.4%	-45.1%	-22.9%
		9.699	-16.8%	-4.2%	-19.4%	-17.0%	-23.1%
	Butyl Acrylate Calibrated Test	0.022	BR	763.6%	BR	344.4%	-88.4%
		0.05	BR	428.9%	BR	160.0%	-33.1%
		0.2	111.1%	114.4%	-27.8%	-22.8%	13.5%
		2	1.1%	13.2%	0.6%	3.4%	-2.7%
		9.699	2.6%	4.3%	4.7%	4.6%	5.2%
Isobutylene	Isobutylene Test	2	10.4%	22.6%	0.4%	0.8%	-4.7%
		10	0.2%	-0.1%	-0.1%	-3.4%	-11.3%
		100	6.3%	-2.2%	35.5%	3.6%	-4.2%
Vinyl Chloride	Vinyl Chloride Test	0.05	BR	344.4%	BR	-20.0%	49.8%
		0.2	-22.2%	58.9%	0.0%	-48.9%	-25.9%
		0.981	1.9%	32.7%	1.9%	-10.5%	-21.1%
		4.937	13.4%	32.9%	21.5%	28.8%	-7.8%
		9.736	19.1%	32.7%	29.4%	24.5%	-5.6%
	Vinyl Chloride Post BA Exposure	0.05	BR	77.8%	BR	157.8%	14.7%
		0.2	77.8%	-6.7%	11.1%	-3.3%	-19.0%
		0.981	11.0%	13.7%	6.5%	2.2%	-6.5%
		4.937	15.2%	28.5%	21.5%	23.3%	-1.1%
		9.736	17.1%	29.1%	34.4%	26.1%	-1.8%

Zero percent equates to no error in measurement.

BR = Below PID measurement range.

**Manufacturer stated concentration.*

≥ -40% or ≤ 40% of x_i | **< -40% or > 40% of x_i**

**Excludes measurements recorded during calibration and following overnight runs. Overnight run measurements were not included as they were not directly comparable to primary tests. Zero air measurement points were excluded due to division by zero errors.*

Table 6.5 Test Accuracy as Mean Relative Error in ppm

			Instrument Model				
Gas Name	**Test Name (group)**	**Target Conc. (ppm)***	**AreaRAE (ER)**	**AreaRAE (PPB)**	**MultiRAE (ER)**	**MultiRAE (PPB)**	**ppbRAE**
Butyl Acrylate	Butyl Acrylate Test	0.00	0.07	0.11	0.07	0.02	0.03
		0.022	BR	0.09	BR	0.00	0.08
		0.05	BR	0.09	BR	-0.03	0.08
		0.2	0.14	0.16	-0.08	-0.15	0.08
		2	-0.35	0.07	-0.81	-0.90	-0.46
		9.699	-1.63	-0.41	-1.89	-1.64	-2.24
	Butyl Acrylate Calibrated Test	0.00	0.13	0.24	0.09	0.10	0.00
		0.022	BR	0.17	BR	0.08	-0.02
		0.05	BR	0.21	BR	0.08	-0.02
		0.2	0.22	0.23	-0.06	-0.05	0.03
		2	0.02	0.26	0.01	0.07	-0.05
		9.699	0.26	0.42	0.46	0.44	0.50
Isobutylene	Isobutylene Test	0.00	0.04	0.10	0.00	0.01	0.00
		2	0.21	0.45	0.01	0.02	-0.09
		10	0.02	-0.01	-0.01	-0.34	-1.13
		100	6.30	-2.21	35.51	3.59	-4.17
Vinyl Chloride	Vinyl Chloride Test	0.00	0.00	0.10	0.00	0.01	0.00
		0.05	BR	0.17	BR	-0.01	0.02
		0.2	-0.04	0.12	0.00	-0.10	-0.05
		0.981	0.02	0.32	0.02	-0.10	-0.21
		4.937	0.66	1.63	1.06	1.42	-0.39
		9.736	1.86	3.18	2.86	2.39	-0.54
	Vinyl Chloride Post BA Exposure	0.00	0.04	0.05	0.03	0.02	0.00
		0.05	BR	0.04	BR	0.08	0.01
		0.2	0.16	-0.01	0.02	-0.01	-0.04
		0.981	0.11	0.13	0.06	0.02	-0.06
		4.937	0.75	1.41	1.06	1.15	-0.06
		9.736	1.66	2.83	3.35	2.54	-0.18

Colors represent accuracy as mean relative percent error.

≤±40%	>±40%	≥±60%	≥±80%	≥±100

BR = Below measurement range.

**Manufacturer stated concentration.*

For the butyl acrylate test, 48% of the mean relative percent errors were outside the range of ± 40% of the target concentration. When calibrated to butyl acrylate, 33% of mean relative percent errors were outside of the specified range. In contrast, 17% of vinyl chloride mean relative percent errors, and 13% of vinyl chloride mean relative percent errors following butyl acrylate exposure, were not within the specified range. All mean relative percent errors for isobutylene were within the specified range.

One sample t-test results (H_0: $\bar{x} = \mu_0$) would initially suggest the assessed PIDs were more accurate in measuring vinyl chloride at concentrations ≤ 0.2 ppm than concentrations > 0.2 ppm (Table 6.6 - Table 6.6b). However, this is due to the previously described decreased precision (Table 6.3) at lower

concentrations. Accuracy was not necessarily improved at vinyl chloride concentrations below 0.2 ppm than concentrations greater than 0.2 ppm. The result may be a mistaken failure to reject H_0 (type II error) at some lower concentrations of vinyl chloride.

Table 6.6 One-sample *t*-test Results for Butyl Acrylate, Vinyl Chloride, and Isobutylene

Fail to Reject H_0: $\bar{x} = \mu_0$	Reject H_0: $\bar{x} = \mu_0$

(a) Butyl Acrylate

		Target Concentration (ppm)					
Equipment Type	**Calibration Gas**	**0.00**	**0.022**	**0.05**	**0.20**	**2.00**	**9.69**
AreaRAE (ER)	Isobutylene		*BR*	*BR*			
	Butyl Acrylate		*BR*	*BR*			
AreaRAE (PPB)	Isobutylene						
	Butyl Acrylate						
MultiRAE (ER)	Isobutylene		*BR*	*BR*			
	Butyl Acrylate		*BR*	*BR*			
MultiRAE (PPB)	Isobutylene						
	Butyl Acrylate						
ppbRAE	Isobutylene						
	Butyl Acrylate						

BR = Below instrument measurement range.

(b) Vinyl Chloride

		Target Concentration (ppm)					
Equipment Type	**Test Type**	**0.00**	**0.05**	**0.20**	**0.98**	**4.94**	**9.74**
AreaRAE (ER)	Pre-BA		*BR*				
	Post-BA		*BR*				
AreaRAE (PPB)	Pre-BA						
	Post-BA						
MultiRAE (ER)	Pre-BA		*BR*				
	Post-BA		*BR*				
MultiRAE (PPB)	Pre-BA						
	Post-BA						
ppbRAE	Pre-BA						
	Post-BA						

BR = Below instrument measurement range.

(c) Isobutylene

	Target Concentration (ppm)			
Equipment Type	**0.00**	**2.00**	**10.00**	**100.00**
AreaRAE (ER)				
AreaRAE (ppb)				
MultiRAE (ER)				
MultiRAE (ppb)				
ppbRAE				

The duration required for all instruments to return to zero ppm, or the baseline concentration, following introduction of 10 ppm butyl acrylate was greater than both isobutylene and vinyl chloride at the same concentration. Vinyl chloride exhibited a similar effect to a lesser degree, and isobutylene least of all. This shift in the zero-point impacted accuracy of tests to varying degrees. In most circumstances, a return to zero ppm was possible within 5-10 minutes following PID exposure to 10 ppm butyl acrylate. However, returning to zero concentration between test cycles was not always achievable within the permitted time frame of ~5 minutes.

To test whether PID exposure to higher concentrations of target gases results in increases in measured concentration at the low end of the target range, three ppbRAEs were two-point calibrated with zero air and 2 ppm isobutylene instead of the three-point calibration used during the primary test assessments. Three cycles supplying the instruments with zero air followed by 0.05 ppm butyl acrylate were conducted. Another test of three cycles of zero air and 0.2 ppm butyl acrylate followed. Cursory analysis would at first suggest accuracy at 0.05 ppm improved by 169.6% and accuracy at 0.2 ppm improved by 34.6%. However, attempts to correct for contamination and inaccurate concentrations in target cylinders appear to alter the outcome. Therefore, it cannot be determined if limiting the concentration of target gas supplied to the PID effectively mitigates observed increases in measurement results at low concentrations with each test cycle.

At the end of each day, one group of three instruments was permitted to run overnight (~12 hours) measuring ambient air. In the morning, a bump check was performed, and morning measurements were compared to those from the previous day. All instrument groups exhibited a decrease in the mean measured concentration between 5% and 28% (Table 6.7).

Table 6.7 Difference in Mean Measured Concentration Over Approximately 12 Hours

Instrument	Mean Difference
ppbRAE	-14.9%
AreaRAE (ER)	-5.0%
AreaRAE (PPB)	-10.2%
MultiRAE (ER)	-10.0%
MultiRAE (PPB)	-28.0%

Each instrument group was assessed against various gases throughout the day and received multiple calibrations. It was observed that instrument zero points would frequently increase throughout testing cycles and return to zero given sufficient run-time. The observed decrease in instrument mean measurement overnight may be typical performance change. However, the decrease may also be due to an elevated zero point due to extended exposure to target gases, multiple calibrations throughout the day, and extended overnight purge time, resulting in a self-cleaning effect. It is not possible from this assessment to determine what proportion of the decrease is related to one, the other, or both of these factors.

Measurements were corrected using Equation 5.9a, the re-analyzed cylinder concentrations in Table 6.1 and the correction factors in Table 6.2. The result was an improvement in accuracy for 65% of the test/instrument combinations (Table 6.8). The results in Table 6.8 were not adjusted for changes in the calibration due to concentration variations in the isobutylene cylinders.

Table 6.8 Mean Percent Error Prior to and After Correcting for Analyzed Cylinder Concentrations

		Cylinder Concentration (ppm)		Assessment Measurement Mean Percent Error	
Test	**Instrument**	***Manufacturer***	***Re-Analyzed (Mean)***	***Manufacturer Cylinder***	***Re-Analyzed Cylinder****
Butyl Acrylate Test	AreaRAE (PPB)	0.022	0.02215	392.9%	389.6%
		0.05	0.26473	180.9%	127.8%
		0.2	0.1563	77.8%	127.5%
	AreaRAE (ER)	2	1.9736	-17.3%	-16.2%
	MultiRAE (PPB)	0.022	0.02215	9.1%	8.4%
		0.05	0.26473	-54.7%	-63.6%
		0.2	0.1563	-77.3%	-71.0%
	ppbRAE	0.022	0.02215	353.9%	350.9%
		0.05	0.2740735	151.2%	68.4%
		0.2	0.1192	39.3%	148.9%
Vinyl Chloride Test	AreaRAE (PPB)	0.05	0.0583	344.4%	281.2%
	AreaRAE (ER)	0.2	0.21321	-22.2%	-27.0%
	MultiRAE Pro (PPB)	0.05	0.0583	-20.0%	-31.4%
	MultiRAE Pro (ER)	0.2	0.21321	0.0%	-6.2%
	ppbRAE	0.05	0.0583	49.8%	28.5%
Vinyl Chloride Post BA Exposure	AreaRAE (PPB)	0.05	0.0583	77.8%	52.5%
	AreaRAE (ER)	0.2	0.21321	77.8%	66.8%
	MultiRAE Pro (PPB)	0.05	0.0583	157.8%	121.1%
	MultiRAE Pro (ER)	0.2	0.21321	0.0%	-6.2%
	ppbRAE	0.05	0.0583	14.7%	-1.7%

Assessment measurements from cylinders which did not receive re-analysis are excluded. No corrections were applied to instrument measurements based on changes in instrument calibration from re-analyzed isobutylene cylinders.
**If a re-analyzed cylinder contained contaminants, the appropriate mixture correction factor contained in Table 6.2 was applied to the measurement from the instrument.*

Since the error in both cylinder concentrations and instrument measurements increased as concentration decreased, it is not possible to determine with certainty what proportion of measurement inaccuracy observed at lower concentrations was due to the cylinder concentration or the instrument. The degree cylinders contributed to the observable trend of decreasing measurement accuracy can also not be determined.

6.4 Vinyl Chloride Measurement following PID Exposure to Butyl Acrylate

To determine the effect on the instrument's ability to measure vinyl chloride following PID exposure to butyl acrylate, vinyl chloride concentrations were re-measured following completion of all other tests and after suppling 10 ppm butyl acrylate to the PID at the start of the test.

Results of two-sample Welch's *t*-tests for each instrument and vinyl chloride concentration indicated there was a statistically significant difference (H_0: $\bar{x}_1 = \bar{x}_2$) between pre-butyl acrylate exposure and post-butyl acrylate exposure for 43% of instrument/concentration combinations (Table 6.9).

Table 6.9 Two-sample *t*-test Results and Summary Statistics for Vinyl Chloride Measurements Pre/Post PID Exposure to Butyl Acrylate

Instrument	Target Conc.	Reject H_0	p-value	Pre-Mean %Error	Post-Mean %Error	Pre-Confidence Interval	Post-Confidence Interval
AreaRAE Pro (PPB)	0	Yes	0.00196	NA	NA	0.110 ± 0.037	0.029 ± 0.031
	0.05	Yes	0.00363	344.4	77.8	0.111 ± 0.032	0.044 ± 0.029
	0.2	Yes	0.00101	58.9	-6.7	0.159 ± 0.029	0.093 ± 0.021
	0.981	Yes	0.00453	32.7	13.7	0.651 ± 0.052	0.558 ± 0.032
	4.937	Yes	0.03004	32.9	28.5	3.281 ± 0.065	3.171 ± 0.079
	9.736	Yes	0.04530	32.7	29.1	6.458 ± 0.102	6.283 ± 0.145
AreaRAE (ER)	0	Yes	0.00086	NA	NA	0.00 ± 0.00	0.04 ± 0.03
	0.2	Yes	0.00217	-22.2	77.8	0.08 ± 0.05	0.18 ± 0.03
	0.981	No	0.29671	1.9	11.0	0.50 ± 0.06	0.54 ± 0.07
	4.937	No	0.82876	13.4	15.2	2.80 ± 0.32	2.84 ± 0.31
	9.736	No	0.77332	19.1	17.1	5.80 ± 0.59	5.70 ± 0.49
MultiRAE Pro (PPB)	0	No	0.07138	NA	NA	0.009 ± 0.010	0.027 ± 0.017
	0.05	Yes	0.00954	-20.0	157.8	0.020 ± 0.020	0.064 ± 0.027
	0.2	Yes	0.01003	-48.9	-3.3	0.051 ± 0.017	0.097 ± 0.029
	0.981	Yes	0.00583	-10.5	2.2	0.439 ± 0.031	0.501 ± 0.031
	4.937	No	0.12051	28.8	23.3	3.180 ± 0.159	3.044 ± 0.088
	9.736	No	0.32711	24.5	26.1	6.061 ± 0.134	6.139 ± 0.106
MultiRAE Pro (ER)	0	No	0.63843	NA	NA	0.01 ± 0.02	0.02 ± 0.02
	0.2	No	0.34659	0.0	11.1	0.10 ± 0.00	0.11 ± 0.03
	0.981	No	0.16902	1.9	6.5	0.50 ± 0.00	0.52 ± 0.03
	4.937	No	NA	21.5	21.5	3.00 ± 0.00	3.00 ± 0.00
	9.736	Yes	0.00003	29.4	34.4	6.30 ± 0.05	6.54 ± 0.08
ppbRAE 3000	0	No	0.33133	NA	NA	0.002 ± 0.005	0.000 ± 0.000
	0.05	No	0.34708	49.8	14.7	0.037 ± 0.015	0.029 ± 0.012
	0.2	No	0.62743	-25.9	-19.0	0.074 ± 0.026	0.081 ± 0.014
	0.981	No	0.09793	-21.1	-6.5	0.387 ± 0.084	0.459 ± 0.009
	4.937	Yes	0.00880	-7.8	-1.1	2.276 ± 0.113	2.440 ± 0.016
	9.736	Yes	0.00816	-5.6	-1.8	4.596 ± 0.123	4.779 ± 0.034

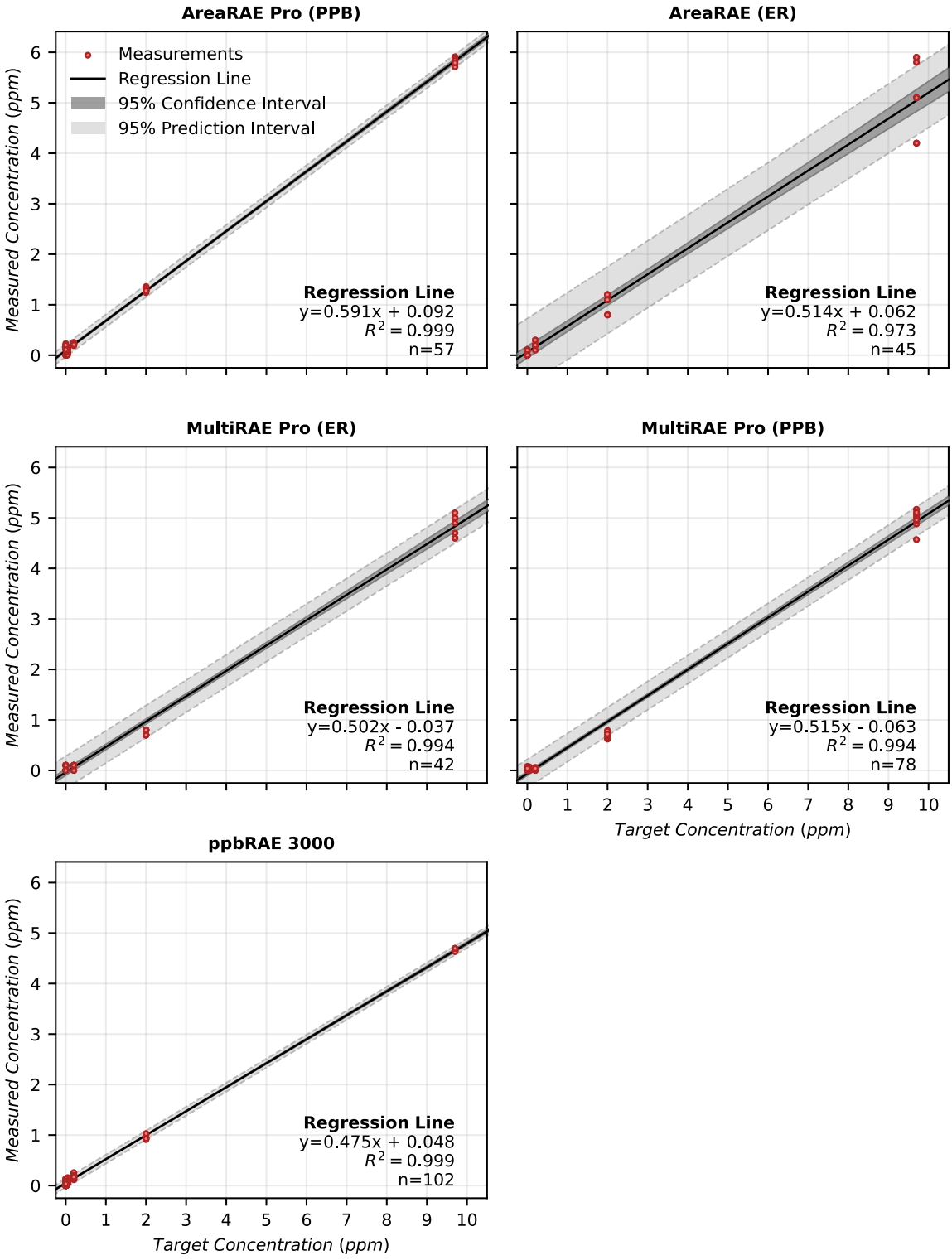
Calculation of mean percent error includes application of mfg. correction factor of 2 to recorded measurements.
Pre/Post = Pre/Post PID exposure to butyl acrylate.
α = 0.05, H_0: $(\bar{x}_1 = \bar{x}_2)$
NA = Not applicable

However, where H_0 was rejected, there was no guarantee the difference adversely impacted performance as accuracy improved for 77% of instrument/concentration combinations for the post-butyl acrylate test. This was most apparent for the AreaRAE Pro (PPB) where a statistically significant difference in the test means was observed at all target concentrations, but following PID exposure to butyl acrylate, accuracy also improved at every target concentration. The mean precision of the overall vinyl concentration range, aggregated across all instruments, improved by 6.4% after PID exposure to butyl acrylate.

6.5 Linear Regression and Experimentally Determined Correction Factors

Least squares linear regression was conducted for all assessments and instrument types to determine the slope, intercept, and coefficient of determination (R^2). Regression analysis was conducted twice on the isobutylene data set, once for the full concentration range (0-100 ppm), and once with the maximum concentration limited to 10 ppm. Since equipment limitations prevent the construction of a traditional calibration method using calibrated mass flow controllers, the 0-10 ppm isobutylene range of the isobutylene tests were used as a surrogate. Additionally, both the isobutylene calibration regression and isobutylene test regression contain isobutylene bump test results conducted during other tests where the instruments were calibrated to isobutylene to increase the sample size (*n*) and capture more variation in instrument performance throughout the assessment. The cylinder concentration stated by the manufacturer was used when constructing the isobutylene calibration regression line and determining the assessment correction factors. Graphs for each regression line (e.g., Figure 6.3) for all instruments and tests, along with additional statistical descriptors for the regression lines, can be found in Appendix E.

Figure 6.3 Butyl Acrylate Test Linear Regression Lines



Regression graphs include zero air bump checks conducted before and/or after the test. Additional tests targeting the lower concentration range of butyl acrylate are also included. This results in variation of the sample size (n) between tested instruments.

Regression lines exhibited strong correlation with R^2 values > 0.97 meeting the DQO for coefficient of determination (R^2) of ≥ 0.9. The manufacturer-provided correction factors for butyl acrylate (1.6) and vinyl chloride (2.0) differed from the experimentally-derived correction factors, which were between 1.66-1.99 and 1.50-1.87 for butyl acrylate and vinyl chloride, respectively (Table 6.10a - Table 6.10f).

Table 6.10 Linear Regression Parameters and Derived Correction Factors (CF)

(a) Butyl Acrylate Test

Instrument	Slope	y-Intercept	R^2	Cal. Slope	Mfg. CF	Assessment CF
AreaRAE (PPB)	0.591 ± 0.005	0.092	0.999	0.981	1.6	1.66
MultiRAE (PPB)	0.515 ± 0.009	-0.063	0.994	0.963	1.6	1.87
ppbRAE	0.475 ± 0.003	0.048	0.999	0.883	1.6	1.86
AreaRAE (ER)	0.514 ± 0.026	0.062	0.973	0.996	1.6	1.94
MulitRAE (ER)	0.502 ± 0.013	-0.037	0.994	0.997	1.6	2.00

(b) Butyl Acrylate Calibrated Test

Instrument	Slope	y-Intercept	R^2	Cal. Slope	Mfg. CF	Assessment CF
AreaRAE (PPB)	1.020 ± 0.007	0.220	0.999	NA	1	NA
MultiRAE (PPB)	1.040 ± 0.008	0.047	0.999	NA	1	NA
ppbRAE	1.052 ± 0.008	-0.029	0.999	NA	1	NA
AreaRAE (ER)	1.012 ± 0.008	0.120	0.999	NA	1	NA
MulitRAE (ER)	1.044 ± 0.010	0.013	0.999	NA	1	NA

NA = Not applicable

(c) Vinyl Chloride Test

Instrument	Slope	y-Intercept	R^2	Cal. Slope	Mfg. CF	Assessment CF
AreaRAE (PPB)	0.656 ± 0.006	0.060	0.999	0.981	2	1.50
MultiRAE (PPB)	0.631 ± 0.010	-0.040	0.997	0.963	2	1.53
ppbRAE	0.472 ± 0.008	-0.020	0.993	0.883	2	1.87
AreaRAE (ER)	0.595 ± 0.028	-0.046	0.973	0.996	2	1.67
MulitRAE (ER)	0.645 ± 0.007	-0.054	0.999	0.997	2	1.55

(d) Vinyl Chloride Post BA Exposure Test

Instrument	Slope	y-Intercept	R^2	Cal. Slope	Mfg. CF	Assessment CF
AreaRAE (PPB)	0.645 ± 0.007	-0.010	0.998	0.981	2	1.52
MultiRAE (PPB)	0.629 ± 0.007	-0.020	0.998	0.963	2	1.53
ppbRAE	0.492 ± 0.002	-0.006	1.000	0.883	2	1.79
AreaRAE (ER)	0.581 ± 0.026	0.016	0.978	0.996	2	1.71
MulitRAE (ER)	0.666 ± 0.010	-0.062	0.997	0.997	2	1.50

(e) Isobutylene Test

Instrument	Slope	y-Intercept	R^2	Cal. Slope	Mfg. CF	Assessment CF
AreaRAE (PPB)	0.975 ± 0.004	0.251	0.999	0.981	1	NA
MultiRAE (PPB)	1.038 ± 0.025	-0.252	0.989	0.963	1	NA
ppbRAE	0.959 ± 0.019	-0.186	0.990	0.883	1	NA
AreaRAE (ER)	1.063 ± 0.015	-0.121	0.995	0.996	1	NA
MulitRAE (ER)	1.360 ± 0.019	-0.974	0.996	0.997	1	NA

NA = Not applicable

(a) Isobutylene Calibration

Instrument	Slope	y-Intercept	R^2	Cal. Slope	Mfg. CF	Assessment CF
AreaRAE (PPB)	0.981 ± 0.010	0.232	0.997	NA	1	NA
MultiRAE (PPB)	0.963 ± 0.012	0.045	0.998	NA	1	NA
ppbRAE	0.883 ± 0.010	0.064	0.997	NA	1	NA
AreaRAE (ER)	0.996 ± 0.008	0.088	0.998	NA	1	NA
MulitRAE (ER)	0.997 ± 0.005	0.017	0.999	NA	1	NA

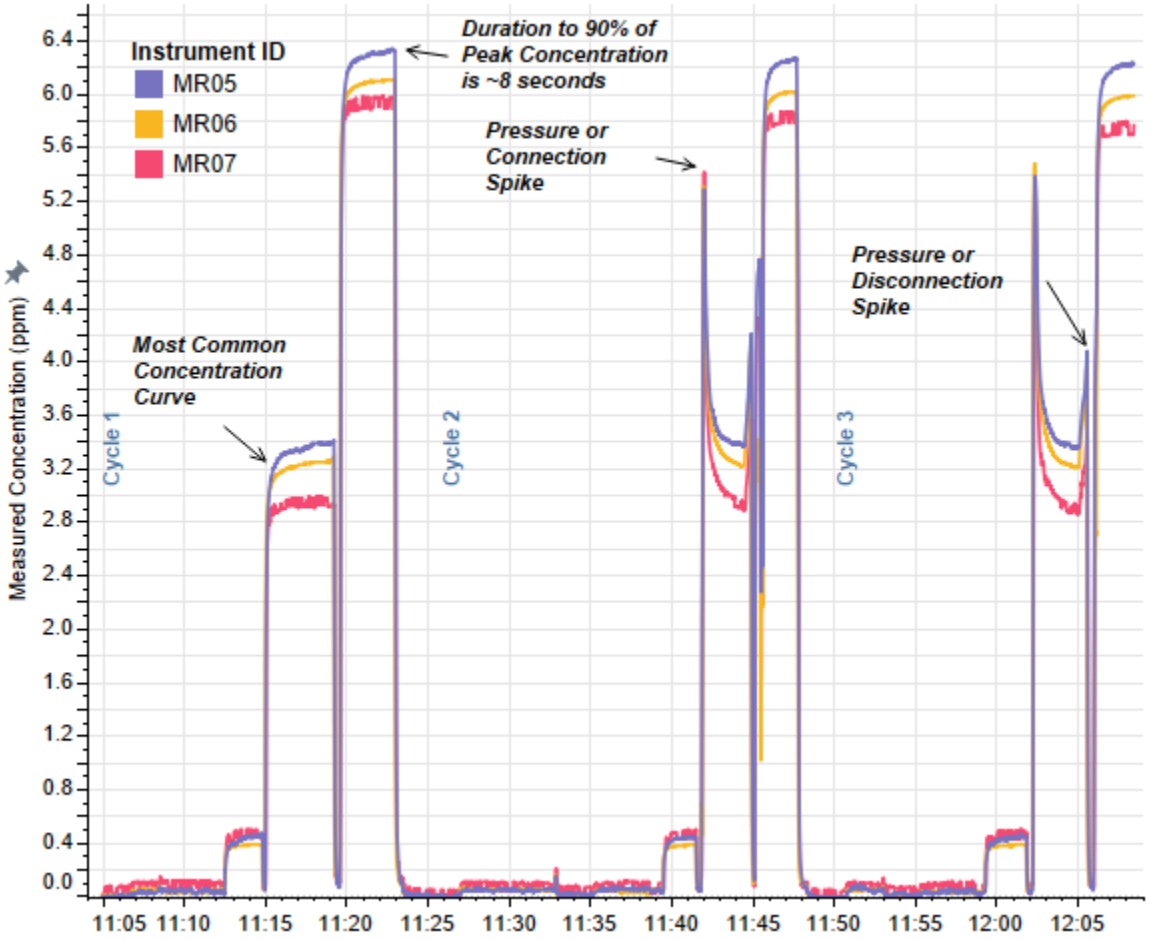
NA = Not applicable

The difference in the derived correction factors and manufacturer correction factors suggests potential underestimation of butyl acrylate (bias low) concentrations between 4% to 20% and over estimation (bias high) of vinyl chloride concentrations between 7% to 33% depending on instrument. However, this analysis does not account for variations in cylinder concentrations and cylinder contaminants.

6.6 Data Logs

A complete analysis and data quality assessment of data within the data logs was not conducted as part of this report in order to provide actionable analysis of PID performance more expediently. Additional graphs of test cycles for data logs similar to Figure 6.4 are provided in Appendix F but may contain erroneous data or data not related to assessment tests as data logging occurred continually when instruments were on. Therefore, data log graphs for assessments are provided for cursory review only with the understanding of the mentioned limitations and as an illustration of the real-time measurements observed during the assessment.

Figure 6.4 Vinyl Chloride Data Log Test Cycle Graph for MultiRAE (PPB)



Due to lack of ability to precisely synchronize internal instrument clocks, the date/time stamps in the above graph have been adjusted to better align instrument responses.

Concentration spikes occurred occasionally when starting gas flow, stopping gas flow, or during cylinder connection/disconnection (Figure 6.4). These spikes appeared to occur more frequently with vinyl chloride measurements using the MultiRAE (PPB) and ppbRAE. The occurrence of these spikes did not appear to be dependent on cylinder type or regulator type. While the design of the gas delivery manifold attempted to maintain pressure of the gas supplied to the instruments to near ambient, this condition may not have been adequately maintained during connections, disconnections, initiating gas flow, discontinuing gas flow, or adjusting gas flow rate at the valve. The cause of these discrepancies cannot be determined at this time.

Most concentration curves appear to have followed a somewhat logarithmic increase in concentration, reaching 90% of the concentration at the end of the cycle within approximately eight seconds (Figure 6.4). This delay may be reduced under field conditions due to the lack of a manifold and supply tubing where target gases mix with ambient or zero air but cannot be determined from this assessment. This logarithmic increase may be the anticipated response as the combined volumes of gas supply lines, manifold, and

internal components would most likely follow the behavior for gas concentration increase in a well-mixed space. Residual contamination of these same components was also a possible contributory source.

This logarithmic increase in concentration supports the decision to limit the time permitted to record a manual measurement to less than 5 minutes as reaching a state where concentration increase becomes nearly equivalent to the asymptote would require considerably more time, particularly for PIDs with resolutions of 0.01 ppm or less. An additional byproduct of the mixing within the manifold, and distance of the gas source to the instrument inlet, was delayed instrument response and an inability to determine instrument response time in the field from data collected during the assessment. In-field instrument response time is anticipated to be less than what was observed during the assessment.

6.7 Instrument Gas Detection Capability

A review of manually recorded concentrations, data logs, and *t*-tests were conducted to assess whether an instrument response occurred when a target gas was supplied to the instrument. Accuracy and precision were not considered in this analysis, only an instrument response (change in measurement). Responses occurring during the first cycle were considered the most reliable as subsequent cycles tended to cause increases in baseline concentrations. Ultimately, some professional judgement was required when classifying responses for target concentrations.

Target concentrations classified as "***Detection Unlikely***" exhibited no response, a response that was not clearly discernible from the zero point or, when a discernible response occurred, was limited to one instrument. The "***Marginal Detection***" classification was assigned to target concentrations where some response greater than the zero point or previous concentration was apparent but appeared inconsistent or had low reproducibility. The MultiRAE (ER) target concentration of 0.2 ppm was classified as "***Indeterminate***" as were all 0.05 ppm butyl acrylate target concentrations for reasons explained in greater detail in subsequent paragraphs. Target concentrations classified as "***Detection***" had a clear response (Table 6.11 and Table 6.12).

Table 6.11 Estimated Ability for Instruments to Detect Butyl Acrylate at Target Concentrations

		Target Concentration (ppm)				
Equipment Type	**Calibration**	**0.022**	**0.05**	**0.20**	**2.00**	**9.699**
AreaRAE (ER)	Isobutylene	*BR*	*BR*			
	Butyl Acrylate	*BR*	*BR*			
AreaRAE (PPB)	Isobutylene					
	Butyl Acrylate					
MultiRAE (ER)	Isobutylene	*BR*	*BR*			
	Butyl Acrylate	*BR*	*BR*			
MultiRAE (PPB)	Isobutylene					
	Butyl Acrylate					
ppbRAE	Isobutylene					
	Butyl Acrylate					

BR = Below instrument measurement range

Detection	Marginal Detection
Indeterminate	Detection Unlikely

Table 6.12 Estimated Ability for Instruments to Detect Vinyl Chloride at Target Concentrations

		Target Concentration (ppm)				
Equipment Type	**Test Type**	**0.05**	**0.20**	**0.98**	**4.94**	**9.74**
AreaRAE (ER)	Pre-BA	*BR*				
	Post-BA	*BR*				
AreaRAE (PPB)	Pre-BA					
	Post-BA					
MultiRAE (ER)	Pre-BA	*BR*				
	Post-BA	*BR*				
MultiRAE (PPB)	Pre-BA					
	Post-BA					
ppbRAE	Pre-BA					
	Post-BA					

BR = Below instrument measurement range

BA = Butyl Acrylate

Detection
Marginal Detection

The ability of the MultiRAE (ER) PID to detect 0.2 ppm butyl acrylate was considered indeterminate. The PID of the MultiRAE (ER) has a resolution of 0.1 ppm, using the manufacturer's correction factor, application of 0.2 ppm butyl acrylate equates to a measurement of 0.125 ppm, which would display as 0.1 ppm on the instrument due to the resolution. Both target gases and calibration gases used in this assessment are known to have variation in actual cylinder concentrations and contamination. While the 0.2 ppm butyl acrylate cylinder (Cylinder BA07) used to test the MultiRAE (ER) was not laboratory analyzed, the two other 0.2 ppm butyl acrylate cylinders used for the assessment were analyzed and discovered to contain 0.081 ppm (Cylinder BA11) and 0.156 ppm (Cylinder BA03) butyl acrylate. Neither cylinder would be anticipated to cause an instrument detection and given that all other butyl acrylate cylinders were biased low, it is reasonable to assume that cylinder BA07 was also biased low. On the second and third test cycles,

all MultiRAE (ER) instruments responded to 0.2 ppm butyl acrylate. As the increase between cycle one and cycle two for PPB model PIDs was less than 0.05 ppm, there is some indication the instrument may have been able to respond if cylinder contents had been accurate, or if cylinder concentration were increased by ~0.05 ppm. At minimum, the response on cycles two and three suggest the MultiRAE (ER) can likely respond to concentrations of butyl acrylate somewhere between 0.3-0.5 ppm, and perhaps 0.2 ppm. Ultimately, this assessment is insufficient to determine with any certainty the ability for the MultiRAE (ER) to detect 0.2 ppm butyl acrylate due to the combination of cylinder contents and the proximity of 0.2 ppm to the instrument's minimum resolution.

All assessed PID's ability to detect butyl acrylate at 0.05 ppm were categorized as indeterminate. All 0.05 ppm butyl acrylate cylinders that received re-analysis were biased low by 0.022 – 0.031 ppm, and several contained ethanol in concentrations greater than butyl acrylate. This bias would have impacted the instrument's ability to accurately measure butyl acrylate and it cannot be adequately determined what amount of inaccuracy was due solely to the instrument and PID.

7.0 Limitations and Additional Research

To expediently address concerns raised regarding PID performance during the East Palestine Train Derailment, the experimental design of the assessment resulted in multiple limitations to be considered.

To minimize introduction of variables and ascertain baseline PID performance, testing was conducted under mostly ideal conditions. New PIDs and lamps were used to prevent influence from age, any potential interference from chemicals of interest, or other previously monitored compounds. Additionally, assessed equipment components have a useful lifespan throughout which some degradation in instrument performance is expected.

As relative humidity and temperature during field use can change throughout the day, variation in instrument performance is anticipated even when calibrated with a humidified gas at an appropriate temperature as the assessed equipment is not capable of continuous calibration verification. Increases in relative humidity have a quenching effect on PID response which results in negative bias, or when condensation occurs, may result in a leak of current and positive bias.[32] All calibration gases used during the assessment and in the field during the East Palestine Train Derailment were not humidified nor were target gases used during the assessment. Furthermore, the assessment was conducted indoors where fluctuations in temperature and humidity were less than what would be expected in an outdoor environment. The impact of relative humidity on the assessment is expected to be negligible or absent; however, corrections of measurements for relative humidity using the absolute concentration of water vapor exist and may be useful in enhancing field measurement accuracy on higher humidity days. As was done with the assessment, the PIDs should ideally be calibrated with a gas near the temperature the equipment is anticipated to operate in for best performance.

Multiple calibration gases and target gases used during the assessment were outside of manufacturer stated specifications, influencing the accuracy and precision of recorded measurements. As a result, challenges were introduced in determining equipment performance particularly at lower concentrations. This was further compounded by the fact that not all cylinders received re-analysis. While some additional data analysis may help correct this confounding factor to a degree, additional PID assessment with higher grade gases is likely necessary.

The experimental design was not appropriate to determine precise instrument response and purge times due to excess gas distribution tubing and manifold. As a result, both response and purge times for PID measurements during the assessment are greater than what would occur in the field.

New butyl acrylate and vinyl chloride correction factors for PIDs calibrated to isobutylene were derived using the assessment data for comparison to the manufacturer provided correction factors. However, their application to historic data or future data may be inappropriate. This limitation of correction factors derived during the assessment is primarily due to the previously discussed issues with gas cylinder

concentrations/contaminants as well as the uncertain influence of the gas distribution system on low concentration measurements. Further analysis of the assessment data may result in improvements to the correction factors derived in this report, but additional PID assessment with higher grade gas and alternate gas supply mechanism is likely needed.

8.0 Conclusions

Performance results were determined for the five Honeywell RAE PIDs with a focus on the ability to detect butyl acrylate when calibrated with isobutylene. Variations in target gas cylinder concentrations outside of manufacturer-stated uncertainties, particularly in isobutylene calibration gas, 0.05 ppm butyl acrylate, and 0.2 ppm butyl acrylate, make determining the actual accuracy of the assessed PIDs challenging. However, these cylinders (excluding analytical grade cylinders)* are commonly used across the industry. For this reason, the inaccuracy of the isobutylene cylinder contents, and the resulting impact on calibration, may or may not be representative of field conditions. The inaccuracies and contaminants discovered in butyl acrylate and vinyl chloride cylinders are more problematic, making extrapolation of instrument accuracy from this assessment to field conditions difficult. Analysis of the MultiRAE (ER) at the 0.2 ppm butyl acrylate concentration was particularly impacted as the cylinder concentration was likely below the theoretical performance capabilities of the instrument. Determining the performance of the MultiRAE (ER) at 0.2 ppm butyl acrylate requires further investigation. To better determine the true performance of these instruments themselves, analytical grade gases should be used for all calibrations and targets. The use of analytical grade gases may also be beneficial for field measurements when higher accuracy at lower concentrations is required.

The cause of the non-linearity at target concentrations less than 0.2 ppm is indeterminate and may be related to a combination of factors including the experimental design, the instruments themselves, and cylinder contents. Trends of increasing concentration per test cycle suggest some degree of residual target gas remains within the gas distribution manifold and/or the instruments themselves resulting in an elevated zero point. The amount this deviation can be attributed to the manifold and tubing system used during this assessment cannot be determined nor would it be appropriate to attribute this behavior entirely to the instruments. Additional caution should be used when drawing conclusions from this assessment about instrument precision in the lower concentration measurement range due to the additional uncertainties regarding cause. Regardless of root cause, to maintain accuracy and precision at low target concentrations for any chemical, it is recommended that the assessed instruments not be used to also measure concentrations in air above 1 ppm to avoid saturating the instrument. Narrowing the target concentration range may help minimize occurrence of positive bias in measurements. If an instrument intended to monitor low concentrations is inadvertently placed in an area of higher concentrations, the instrument should be removed to an area with clean air until returning to zero or, dependent on objectives, another appropriately low concentration. Selecting calibration gas concentrations as close to the desired measurement range as feasible may also minimize positive bias and downward drift as the instrument self purges. Any zero-point calibration should occur prior to calibration with other gases.

While assessed instrument accuracy and precision did not always meet the DQOs of this assessment, particularly in the lower measurement range, the assessed instruments provide a degree of utility and

**Analytical grade cylinders manufactured by Apel-Riemer, Linde, and Airgas (Table 5.1).*

advantages so long as limitations are understood and accounted for. The acceptability of deviations in accuracy up to and even exceeding 100% of the target concentration is dependent in its entirety on the set objectives and does not necessarily preclude use. These responses, combined with the instruments' abilities to measure concentrations in real time, allow users to make immediate decisions based on changes in conditions. Excluding the MultiRAE (ER), which requires further assessment, all instruments exhibited responses at concentrations ≥ 0.2 ppm butyl acrylate and vinyl chloride. Concentrations of butyl acrylate < 0.2 ppm and vinyl chloride < 0.05 ppm may be possible, but further assessment is needed.

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Appendix A: Equipment Inventory

Table A.1 Equipment Inventory

Equipment ID	Owner	Manufacturer	Model Name	Model Number	Sensor Resolution (ppm)	Serial Number	Firmware Version	Comments
AR01	CTEH	Honeywell	AreaRAE Plus (ER)	PGM6520A	0.1	W01B00000958	1.08	Removed from service due to faulty pump
AR02	CTEH	Honeywell	AreaRAE Plus (ER)	PGM6520A	0.1	W01B00002132	1.08	
AR03	CTEH	Honeywell	AreaRAE Plus (ER)	PGM6520A	0.1	W01B00000955	1.08	Data log not recoverable
AR04	CTEH	Honeywell	AreaRAE Plus (ER)	PGM6520A	0.1	W01B00000949	1.08	
AR05	CTEH	Honeywell	AreaRAE Plus (ER)	PGM6520D	0.1	W01B00000652	1.08	Water Damaged. Removed from service. (Not Used)
AR10	START	Honeywell	AreaRAE Pro (ER)	PGM6560D	0.1	W01A00002173	2.22A	Same unit as AR07
AR07	START	Honeywell	AreaRAE Pro (PPB)	PGM6560D	0.01	W01A00002173	2.22A	
AR08	START	Honeywell	AreaRAE Pro (PPB)	PGM6560D	0.01	W01A00002176	2.22A	
AR09	START	Honeywell	AreaRAE Pro (PPB)	PGM6560D	0.01	W01A00002133	2.22A	
DC01	CTEH	MesaLabs	DryCal Defender 520	520-M Rev C1	NA	179689	2.10	
MR01	CTEH	Honeywell	MultiRAE Pro (ER)	PGM6248	0.1	M01EA17442	1.54	
MR02	CTEH	Honeywell	MultiRAE Pro (ER)	PGM6288	0.1	M01FA06487	1.54	
MR03	CTEH	Honeywell	MultiRAE Pro (ER)	Unknown	0.1	M01FA03284	1.54	Model Label Missing
MR04	CTEH	Honeywell	MultiRAE Pro (ER)	PGM6288	0.1	M01EA18303	1.54	
MR05	START	Honeywell	MultiRAE Pro (PPB)	PGM6208	0.01	MCB3Z015N9	1.54	
MR06	START	Honeywell	MultiRAE Pro (PPB)	PGM6248	0.01	M01FA04152	1.54	
MR07	START	Honeywell	MultiRAE Pro (PPB)	PGM6248	0.01	M01FA05265	1.54	

Table A.1 Equipment Inventory

Equipment ID	Owner	Manufacturer	Model Name	Model Number	Sensor Resolution (ppm)	Serial Number	Firmware Version	Comments
PR01	Northside Sales	Honeywell	ppbRAE 3000	PGM7340	0.001	594-902865	2.22A	Calibration issues on 5/1/2023. Removed from service
PR03	CTEH	Honeywell	ppbRAE 3000	PGM7340	0.001	594-901442	2.22A	
PR04	CTEH	Honeywell	ppbRAE 3000	PGM7340	0.001	594-901401	2.22A	
PR02	Northside Sales	Honeywell	ppbRAE 3000+	PGM7340	0.001	594-916121	2.22A	

NA=Not Applicable

Appendix B: Gas Cylinder Inventory and Certificates of Analysis

Table B.1 Assessment Gas Cylinder Inventory

Cylinder ID	Manufacturer	Gas Name	Mfg. Concentration. (ppm)	Uncertainty	Serial Number	Lot Number	Volume (L)	Pressure (psi)	Expiration Date
A01	AirGas	Ultra Zero	0.000	Not Provided*	AI UZ300	132-402600628-1	8,835	2,400	Not Provided*
BA01	Linde	Butyl Acrylate	0.022	20	AB-117872	NA	98	1,700	2024-04-17
BA02	PortaGas	Butyl Acrylate	0.050	10	BE175430	279929	100	1,000	2023-11-01
BA03	PortaGas	Butyl Acrylate	0.200	10	BE175827	279930	100	1,000	2023-11-01
BA04	PortaGas	Butyl Acrylate	2.000	5	BE175824	279931	100	1,000	2023-11-01
BA05	Apel-Riemer	Butyl Acrylate	9.699	5	D163822	23112.4		2,000	2024-04-26
BA06	PortaGas	Butyl Acrylate	0.050	10	BE175825	279929	100	1,000	2023-11-01
BA07	PortaGas	Butyl Acrylate	0.200	10	BE175818	279930	100	1,000	2023-11-01
BA08	PortaGas	Butyl Acrylate	2.000	5	BE176603	279931	100	1,000	2023-11-01
BA09	PortaGas	Butyl Acrylate	2.000	5	BE176567	279931	100	1,000	2023-11-01
BA10	PortaGas	Butyl Acrylate	2.000	5	BE176528	279931	100	1,000	2023-11-01
BA11	PortaGas	Butyl Acrylate	0.200	10	BE175812	279930	100	1,000	2023-11-01
IS01	PortaGas	Isobutylene	2.000	5	BC582395	279838	116	1,000	2026-05-01
IS02	PortaGas	Isobutylene	10.000	5	BE171400	276458	100	1,000	2026-04-01
IS03	PortaGas	Isobutylene	100.000	2	BE153954	277693	100	1,000	2026-03-01
IS04	PortaGas	Isobutylene	2.000	5	BC486888	279838	116	1,000	2026-05-01
IS05	PortaGas	Isobutylene	10.000	5	BE180189	280462	100	1,000	2026-05-01
IS06	PortaGas	Isobutylene	10.000	5	BE175654	280044	100	1,000	2026-05-01
IS07	PortaGas	Isobutylene	2.000	5	BC582384	281107	116	1,000	2026-06-01
IS08	PortaGas	Isobutylene	10.000	5	BE178997	281104	100	1,000	2026-06-01
IS09	PortaGas	Isobutylene	10.000	5	BE178995	281104	100	1,000	2026-06-01
IS10	PortaGas	Isobutylene	2.000	5	BC579730	281107	100	1,000	2026-06-01
IS11	PortaGas	Isobutylene	10.000	5	BE175642	280044	100	1,000	2026-05-01
IS12	PortaGas	Isobutylene	2.000	5	BC583029	281107	116	1,000	2026-06-01
IS13	PortaGas	Isobutylene	100.000	2	BE154672	277693	100	1,000	2026-04-01
V01	PortaGas	Vinyl Chloride	0.050	10	BE181976	280719	100	1,000	2025-05-01
V02	PortaGas	Vinyl Chloride	0.200	10	BE182245	280722	100	1,000	2025-05-01
V03	Apel-Riemer	Vinyl Chloride	0.981	5	D163832	23112.1		2,000	2024-04-26
V04	Apel-Riemer	Vinyl Chloride	4.937	5	D163829	23112.2		2,000	2024-04-26
V05	Apel-Riemer	Vinyl Chloride	9.736	5	D163834	23112.3		2,000	2024-04-26
V06	PortaGas	Vinyl Chloride	0.200	10	BE182016	280722	100	1,000	2025-05-01

**No Expiration Date. Analyzed by Enthalpy for trace components by TO-15.*

SHIPPED TO: Centenary United Methodist Church
40 S Market St.
East Palestine, OH 44413

PAGE: 1 of 1

ANALYSIS REPORT

Sales#:	117472939	**Cylinder Size:**	185 (3.2" X 9.4")
Production#:	1585683	**Cylinder # :**	AB-117872
Report Date:	Apr-17-2023	**Cylinder Pressure:**	1700 psig
P.O.# :	75479767	**Cylinder Valve:**	CGA 180 / Aluminum
Blend Type:	QUALIFIED	**Cylinder Volume:**	0.8 Liter
Material#:	24111055	**Cylinder Material:**	Aluminum
Traceability:	NIST by weight	**Gas Volume:**	98 Liters
Expiration Date:	Apr-17-2024	**Blend Tolerance:**	20% Relative
Do NOT use under:	150 psig	**Analytical Accuracy:**	20% Relative

COMPONENT	CAS NUMBER	REQUESTED CONC	QUALIFIED CONC
n-Butyl Acrylate	141-32-2	20 ppb	22 ppb
Air	132259-10-0	Balance	Balance

ANALYST: Lou Lorenzetti

DATE: Apr-17-2023

Linde Gas North America LLC
(908) 329-9700 Main (908) 329-9740 Fax
www.Lindeus.com

CERTIFICATE OF ANALYSIS

PortaGas™
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1202 E Sam Houston Parkway S,
Pasadena, TX 77503
Phone:(800) 548 2268 Fax:(713) 928 9961

PO Number: 02457911623

Certification Date: 04-Apr-2023

Manufactured For:
CTEH Center for Toxicology & Environmental Health
5120 North Shore Drive
North Little Rock AR 72118
United States Of America

Customer Part No:

Cylinder Size: 100GAL

Cylinder Content: 100 L (3.5 CU.FT.) @ 70 F (21 C) & 1000 PSIG (6890Kpag)

Cylinder Lot No: 279929

Cylinder Serial Nos: BE175430,BE175813,BE175819,BE175823,BE175825

Unit Of Measure: Mole

Expiration Date: Nov 2023

Component	Nominal	Uncertainty	
BUTYL ACRYLATE	50 PPB (vol)	+/-10%	
AIR	BALANCE		

The mixture was manufactured or transfilled from a standard which has been gravimetrically blended with traceability through NIST to the International System of Units (SI) balance. Balances are calibrated by a certified third party with certified NIST weights and NIST test numbers.**Report Number: BU70910-051123.**The uncertainty is expressed as an expanded uncertainty *U=kuc* with *uc* determined by experiment and a coverage factor *k=2*. The certified value +/-U is presented with a level of confidence of approximately 95%.

Quality Assurance Manager

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PO Number: 02457911623

Certification Date: 04-Apr-2023

Manufactured For:
CTEH Center for Toxicology & Environmental Health
5120 North Shore Drive
North Little Rock AR 72118
United States Of America

Customer Part No:
Cylinder Size: 100GAL
Cylinder Content: 100 L (3.5 CU.FT.) @ 70 F (21 C) & 1000 PSIG (6890Kpag)
Cylinder Lot No: 279930
Cylinder Serial Nos: BE175428,BE175812,BE175818,BE175821,BE175827
Unit Of Measure: Mole
Expiration Date: Nov 2023

Component	Nominal	Uncertainty	
BUTYL ACRYLATE	200 PPB (vol)	+/-10%	
AIR	BALANCE		

The mixture was manufactured or transfilled from a standard which has been gravimetrically blended with traceability through NIST to the International System of Units (SI) balance. Balances are calibrated by a certified third party with certified NIST weights and NIST test numbers.**Report Number: BU70910-051123.**The uncertainty is expressed as an expanded uncertainty *U=kuc* with *uc* determined by experiment and a coverage factor *k=2*. The certified value +/-U is presented with a level of confidence of approximately 95%.

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PO Number: 02457911623

Certification Date: 04-Apr-2023

Manufactured For:
CTEH Center for Toxicology & Environmental Health
5120 North Shore Drive
North Little Rock AR 72118
United States Of America

Customer Part No:

Cylinder Size: 100GAL

Cylinder Content: 100 L (3.5 CU.FT.) @ 70 F (21 C) & 1000 PSIG (6890Kpag)

Cylinder Lot No: 279931

Cylinder Serial Nos: BE175820,BE175824,BE176528,BE176567,BE176603

Unit Of Measure: Mole

Expiration Date: Nov 2023

Component	Nominal	Uncertainty	
BUTYL ACRYLATE	2 PPM (vol)	+/-5%	
AIR	BALANCE		

The mixture was manufactured or transfilled from a standard which has been gravimetrically blended with traceability through NIST to the International System of Units (SI) balance. Balances are calibrated by a certified third party with certified NIST weights and NIST test numbers.**Report Number: BU70910-051123.**The uncertainty is expressed as an expanded uncertainty *U=kuc* with *uc* determined by experiment and a coverage factor *k=2*. The certified value +/-U is presented with a level of confidence of approximately 95%.

Quality Assurance Manager

APEL-RIEMER ENVIRONMENTAL, INC

REFERENCE GASES AND ATMOSPHERIC CHEMISTRY

Certificate of Analysis

Gas-phase Calibration Standard

This gas-phase standard is intended to be used as a reference material for the calibration of instruments.

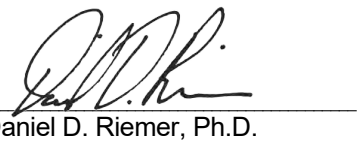
Statement about preparation and traceability:

Standards are gravimetrically prepared in high-pressure aluminum cylinders (Luxfer, Inc., Riverside, California). Cylinders are cleaned and treated to eliminate contamination and ensure inertness. Standards are prepared in N150 cylinders (~4000 Liters calibration gas), N033 cylinders (~800 Liters calibration gas), or N006 cylinders (~125 Liters calibration gas at a pressure of 2000 psia UHP nitrogen or Ultra-Pure air. Valves are high purity stainless steel (Ceodeux, Lintgen, Luxembourg) with a CGA-350 fitting. Pure compounds as liquids and gases are obtained from a number of sources. All lot numbers are cataloged. The gravimetric preparation is performed using calibrated microbalances (Mettler-Toledo, Columbus, Ohio) and microsyringes (Hamilton, Reno, Nevada and SGE, Austin, Texas) for measuring the compounds and cylinder balances (Mettler-Toledo, Columbus, Ohio) for the balance gas. Balances are calibrated with NIST traceable weights.

We prepare each cylinder individually. Accuracy is better than +/- 5%. Analysis confirms the accuracy of the gravimetric preparation. We use a series of NIST, NIST-traceable, NPL, and in-house gravimetric standards to perform the instrument calibrations.

Stability varies depending on the compound, concentration, and cylinder size. Many compounds are stable for several years.

The calibration gas mixture in cylinder D163822 is certified from the analysis date for 12 months.



Daniel D. Riemer, Ph.D.

April 26, 2023
Date

1295 NW 163rd Street, Miami, Florida 33169 USA
Telephone: 786-925-6201 / Fax: 786-364-1591
Email: info@apelriemerenvironmental.com

Cylinder: D163822
Cylinder Date: 01/23
Valve: SS CGA350 21/302886 C/R
Lot No.: 23112.4
Cylinder Pressure: 2000 psia
Analysis Date: April 26, 2023

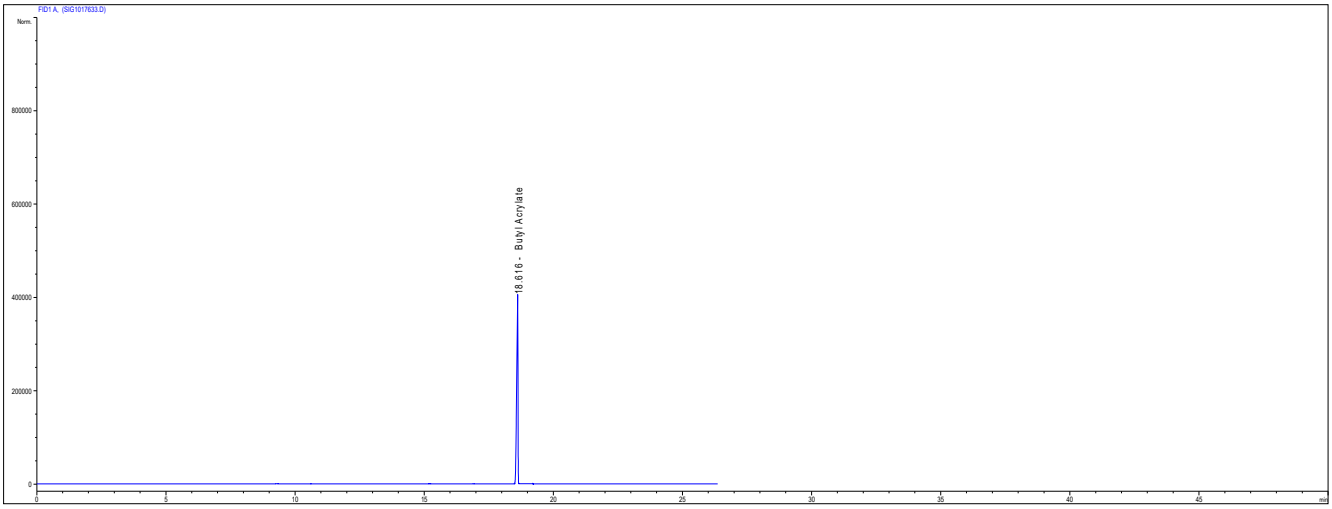
Single-component calibration mixture in ultra-pure air

Compound	CAS#	Concentration (ppb)	Uncertainty
Butyl Acrylate	141-32-2	9699	±5%

Uncertainty is a conservative estimate of the combination of the uncertainties of the gravimetric preparation and analysis.

Chromatogram

100-meter DB-1, 0.25 mm id, 3.1 mL min^{-1} Helium carrier gas – constant flow
Temperature Program: 35°C, 3.5 min → 4.5°C min^{-1} → 180 °C, 6 min



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1202 E Sam Houston Parkway S,
Pasadena, TX 77503
Phone:(800) 548 2268 Fax:(713) 928 9961

PO Number: 02457911659

Certification Date: 03-Apr-2023

Manufactured For:
CTEH Center for Toxicology & Environmental Health
5120 North Shore Drive
North Little Rock AR 72118
United States Of America

Customer Part No:

Cylinder Size: 116GAL

Cylinder Content: 116 L (4.1 CU.FT.) @ 70 F (21 C) & 1000 PSIG (6890Kpag)

Cylinder Lot No: 279838

Cylinder Serial Nos: BC486888,BC582395

Unit Of Measure: Mole

Expiration Date: May 2026

Component	Nominal	Uncertainty	
ISO-BUTYLENE	2 PPM (vol)	+/-5%	
AIR	BALANCE		

The mixture was manufactured or transfilled from a standard which has been gravimetrically blended with traceability through NIST to the International System of Units (SI) balance. Balances are calibrated by a certified third party with certified NIST weights and NIST test numbers.**Report Number: BU70910-051123.**The uncertainty is expressed as an expanded uncertainty *U=kuc* with *uc* determined by experiment and a coverage factor *k=2*. The certified value +/-U is presented with a level of confidence of approximately 95%.

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Phone:(800) 548 2268 Fax:(713) 928 9961

PO Number: 02457911779

Certification Date: 03-May-2023

Manufactured For:
CTEH Center for Toxicology & Environmental Health
5120 North Shore Drive
North Little Rock AR 72118
United States Of America

Customer Part No:

Cylinder Size: 116GAL

Cylinder Content: 116 L (4.1 CU.FT.) @ 70 F (21 C) & 1000 PSIG (6890Kpag)

Cylinder Lot No: 281107

Cylinder Serial Nos: BC579730,BC582384,BC583029

Unit Of Measure: Mole

Expiration Date: Jun 2026

Component	Nominal	Uncertainty	
ISO-BUTYLENE	2 PPM (vol)	+/-5%	
AIR	BALANCE		

The mixture was manufactured or transfilled from a standard which has been gravimetrically blended with traceability through NIST to the International System of Units (SI) balance. Balances are calibrated by a certified third party with certified NIST weights and NIST test numbers.**Report Number: BU70910-051123.**The uncertainty is expressed as an expanded uncertainty *U=kuc* with *uc* determined by experiment and a coverage factor *k=2*. The certified value +/-U is presented with a level of confidence of approximately 95%.

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Certification Date: 03-Apr-2023

Manufactured For:
CTEH Center for Toxicology & Environmental Health
5120 North Shore Drive
North Little Rock AR 72118
United States Of America

Customer Part No:

Cylinder Size: 116GAL

Cylinder Content: 116 L (4.1 CU.FT.) @ 70 F (21 C) & 1000 PSIG (6890Kpag)

Cylinder Lot No: 279838

Cylinder Serial Nos: BC486888,BC582395

Unit Of Measure: Mole

Expiration Date: May 2026

Component	Nominal	Uncertainty	
ISO-BUTYLENE	2 PPM (vol)	+/-5%	
AIR	BALANCE		

The mixture was manufactured or transfilled from a standard which has been gravimetrically blended with traceability through NIST to the International System of Units (SI) balance. Balances are calibrated by a certified third party with certified NIST weights and NIST test numbers.**Report Number: BU70910-051123.**The uncertainty is expressed as an expanded uncertainty *U=kuc* with *uc* determined by experiment and a coverage factor *k=2*. The certified value +/-U is presented with a level of confidence of approximately 95%.

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PO Number: 02457911779

Certification Date: 03-May-2023

Manufactured For:
CTEH Center for Toxicology & Environmental Health
5120 North Shore Drive
North Little Rock AR 72118
United States Of America

Customer Part No:

Cylinder Size: 116GAL

Cylinder Content: 116 L (4.1 CU.FT.) @ 70 F (21 C) & 1000 PSIG (6890Kpag)

Cylinder Lot No: 281107

Cylinder Serial Nos: BC579730,BC582384,BC583029

Unit Of Measure: Mole

Expiration Date: Jun 2026

Component	Nominal	Uncertainty	
ISO-BUTYLENE	2 PPM (vol)	+/-5%	
AIR	BALANCE		

The mixture was manufactured or transfilled from a standard which has been gravimetrically blended with traceability through NIST to the International System of Units (SI) balance. Balances are calibrated by a certified third party with certified NIST weights and NIST test numbers.**Report Number: BU70910-051123.**The uncertainty is expressed as an expanded uncertainty *U=kuc* with *uc* determined by experiment and a coverage factor *k=2*. The certified value +/-U is presented with a level of confidence of approximately 95%.

Quality Assurance Manager

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1202 E Sam Houston Parkway S,
Pasadena, TX 77503
Phone:(800) 548 2268 Fax:(713) 928 9961

PO Number: 02457911577

Certification Date: 09-Mar-2023

Manufactured For:
CTEH Center for Toxicology & Environmental Health
5120 North Shore Drive
North Little Rock AR 72118
United States Of America

Customer Part No:
Cylinder Size: 100GAL
Cylinder Content: 100 L (3.5 CU.FT.) @ 70 F (21 C) & 1000 PSIG (6890Kpag)
Cylinder Lot No: 276458
Cylinder Serial Nos: BE170183,BE171400
Unit Of Measure: Mole
Expiration Date: Apr 2026

Component	Nominal	Uncertainty	Analytical Method
ISO-BUTYLENE	10 PPM (vol)	+/-5%	PID
AIR	BALANCE		

The mixture was manufactured or transfilled from a standard which has been gravimetrically blended with traceability through NIST to the International System of Units (SI) balance. Balances are calibrated by a certified third party with certified NIST weights and NIST test numbers.**Report Number: BU70910-051123.**The uncertainty is expressed as an expanded uncertainty *U=kuc* with *uc* determined by experiment and a coverage factor *k=2*. The certified value +/-U is presented with a level of confidence of approximately 95%.

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1202 E Sam Houston Parkway S,
Pasadena, TX 77503
Phone:(800) 548 2268 Fax:(713) 928 9961

PO Number: 02457911686

Certification Date: 07-Apr-2023

Manufactured For:
CTEH Center for Toxicology & Environmental Health
5120 North Shore Drive
North Little Rock AR 72118
United States Of America

Customer Part No:

Cylinder Size: 100GAL

Cylinder Content: 100 L (3.5 CU.FT.) @ 70 F (21 C) & 1000 PSIG (6890Kpag)

Cylinder Lot No: 280044

Cylinder Serial Nos: BE175642,BE175654

Unit Of Measure: Mole

Expiration Date: May 2026

Component	Nominal	Uncertainty	Analytical Method
ISO-BUTYLENE	10 PPM (vol)	+/-5%	(TCD) Gas Chromatography_US00024275
AIR	BALANCE		

The mixture was manufactured or transfilled from a standard which has been gravimetrically blended with traceability through NIST to the International System of Units (SI) balance. Balances are calibrated by a certified third party with certified NIST weights and NIST test numbers.**Report Number: BU70910-051123.**The uncertainty is expressed as an expanded uncertainty *U=kuc* with *uc* determined by experiment and a coverage factor *k=2*. The certified value +/-U is presented with a level of confidence of approximately 95%.

Quality Assurance Manager

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ISO/IEC 17025:2017 ACCREDITED

1202 E Sam Houston Parkway S,
Pasadena, TX 77503
Phone:(800) 548 2268 Fax:(713) 928 9961

PO Number: 02457911779

Certification Date: 03-May-2023

Manufactured For:
CTEH Center for Toxicology & Environmental Health
5120 North Shore Drive
North Little Rock AR 72118
United States Of America

Customer Part No:
Cylinder Size: 100GAL
Cylinder Content: 100 L (3.5 CU.FT.) @ 70 F (21 C) & 1000 PSIG (6890Kpag)
Cylinder Lot No: 281104
Cylinder Serial Nos: BE178995,BE178997
Unit Of Measure: Mole
Expiration Date: Jun 2026

Component	Nominal	Uncertainty	Analytical Method
ISO-BUTYLENE	10 PPM (vol)	+/-5%	PID
AIR	BALANCE		

The mixture was manufactured or transfilled from a standard which has been gravimetrically blended with traceability through NIST to the International System of Units (SI) balance. Balances are calibrated by a certified third party with certified NIST weights and NIST test numbers.**Report Number: BU70910-051123.**The uncertainty is expressed as an expanded uncertainty *U=kuc* with *uc* determined by experiment and a coverage factor *k=2*. The certified value +/-U is presented with a level of confidence of approximately 95%.

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1202 E Sam Houston Parkway S,
Pasadena, TX 77503
Phone:(800) 548 2268 Fax:(713) 928 9961

PO Number: 02457911725

Certification Date: 18-Apr-2023

Manufactured For:
CTEH Center for Toxicology & Environmental Health
5120 North Shore Drive
North Little Rock AR 72118
United States Of America

Customer Part No:
Cylinder Size: 100GAL
Cylinder Content: 100 L (3.5 CU.FT.) @ 70 F (21 C) & 1000 PSIG (6890Kpag)
Cylinder Lot No: 280462
Cylinder Serial Nos: BE178905,BE180189
Unit Of Measure: Mole
Expiration Date: May 2026

Component	Nominal	Uncertainty	Analytical Method
ISO-BUTYLENE	10 PPM (vol)	+/-5%	PID
AIR	BALANCE		

The mixture was manufactured or transfilled from a standard which has been gravimetrically blended with traceability through NIST to the International System of Units (SI) balance. Balances are calibrated by a certified third party with certified NIST weights and NIST test numbers.**Report Number: BU70910-051123.**The uncertainty is expressed as an expanded uncertainty *U=kuc* with *uc* determined by experiment and a coverage factor *k=2*. The certified value +/-U is presented with a level of confidence of approximately 95%.

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ISO/IEC 17025:2017 ACCREDITED

1202 E Sam Houston Parkway S,
Pasadena, TX 77503
Phone:(800) 548 2268 Fax:(713) 928 9961

PO Number: 02457911542

Certification Date: 24-Feb-2023

Manufactured For:
CTEH Center for Toxicology & Environmental Health
5120 North Shore Drive
North Little Rock AR 72118
United States Of America

Customer Part No:
Cylinder Size: 100GAL
Cylinder Content: 100 L (3.5 CU.FT.) @ 70 F (21 C) & 1000 PSIG (6890Kpag)
Cylinder Lot No: 277693
Cylinder Serial Nos: BE153954
Unit Of Measure: Mole
Expiration Date: Mar 2026

Component	Nominal	Uncertainty	Analytical Method
ISO-BUTYLENE	100 PPM (vol)	+/-2%	PID
AIR	BALANCE		

The mixture was manufactured or transfilled from a standard which has been gravimetrically blended with traceability through NIST to the International System of Units (SI) balance. Balances are calibrated by a certified third party with certified NIST weights and NIST test numbers.**Report Number: BU70910-051123.**The uncertainty is expressed as an expanded uncertainty *U=kuc* with *uc* determined by experiment and a coverage factor *k=2*. The certified value +/-U is presented with a level of confidence of approximately 95%.

Quality Assurance Manager

CERTIFICATE OF ANALYSIS

PortaGas™
A Linde company

ISO 9001:2015 CERTIFIED
ISO 17034:2016 ACCREDITED
ISO/IEC 17025:2017 ACCREDITED

1202 E Sam Houston Parkway S,
Pasadena, TX 77503
Phone:(800) 548 2268 Fax:(713) 928 9961

PO Number: 02457911577

Certification Date: 09-Mar-2023

Manufactured For:
CTEH Center for Toxicology & Environmental Health
5120 North Shore Drive
North Little Rock AR 72118
United States Of America

Customer Part No:

Cylinder Size: 100GAL

Cylinder Content: 100 L (3.5 CU.FT.) @ 70 F (21 C) & 1000 PSIG (6890Kpag)

Cylinder Lot No: 277693

Cylinder Serial Nos: BE153820,BE153944,BE154443,BE154672

Unit Of Measure: Mole

Expiration Date: Apr 2026

Component	Nominal	Uncertainty	Analytical Method
ISO-BUTYLENE	100 PPM (vol)	+/-2%	PID
AIR	BALANCE		

The mixture was manufactured or transfilled from a standard which has been gravimetrically blended with traceability through NIST to the International System of Units (SI) balance. Balances are calibrated by a certified third party with certified NIST weights and NIST test numbers.**Report Number: BU70910-051123.**The uncertainty is expressed as an expanded uncertainty *U=kuc* with *uc* determined by experiment and a coverage factor *k=2*. The certified value +/-U is presented with a level of confidence of approximately 95%.

Quality Assurance Manager

CERTIFICATE OF ANALYSIS

PortaGas™
A Linde company

ISO 9001:2015 CERTIFIED
ISO 17034:2016 ACCREDITED
ISO/IEC 17025:2017 ACCREDITED

1202 E Sam Houston Parkway S,
Pasadena, TX 77503
Phone:(800) 548 2268 Fax:(713) 928 9961

PO Number: 02457911704

Certification Date: 24-Apr-2023

Manufactured For:
CTEH Center for Toxicology & Environmental Health
5120 North Shore Drive
North Little Rock AR 72118
United States Of America

Customer Part No:
Cylinder Size: 100GAL
Cylinder Content: 100 L (3.5 CU.FT.) @ 70 F (21 C) & 1000 PSIG (6890Kpag)
Cylinder Lot No: 280719
Cylinder Serial Nos: BE180465,BE181963,BE181976,BE181987,BE182011,BE182123
Unit Of Measure: Mole
Expiration Date: May 2025

Component	Nominal	Uncertainty	
VINYL CHLORIDE	50 PPB (vol)	+/-10%	
AIR	BALANCE		

The mixture was manufactured or transfilled from a standard which has been gravimetrically blended with traceability through NIST to the International System of Units (SI) balance. Balances are calibrated by a certified third party with certified NIST weights and NIST test numbers.**Report Number: BU70910-051123.**The uncertainty is expressed as an expanded uncertainty *U=kuc* with *uc* determined by experiment and a coverage factor *k=2*. The certified value +/-U is presented with a level of confidence of approximately 95%.

Quality Assurance Manager

CERTIFICATE OF ANALYSIS

PortaGas™
A Linde company

ISO 9001:2015 CERTIFIED
ISO 17034:2016 ACCREDITED
ISO/IEC 17025:2017 ACCREDITED

1202 E Sam Houston Parkway S,
Pasadena, TX 77503
Phone:(800) 548 2268 Fax:(713) 928 9961

PO Number: 02457911704

Certification Date: 24-Apr-2023

Manufactured For:
CTEH Center for Toxicology & Environmental Health
5120 North Shore Drive
North Little Rock AR 72118
United States Of America

Customer Part No:

Cylinder Size: 100GAL

Cylinder Content: 100 L (3.5 CU.FT.) @ 70 F (21 C) & 1000 PSIG (6890Kpag)

Cylinder Lot No: 280722

Cylinder Serial Nos: BE180468,BE180470,BE180471,BE181992,BE182016,BE182245

Unit Of Measure: Mole

Expiration Date: May 2025

Component	Nominal	Uncertainty	
VINYL CHLORIDE	200 PPB (vol)	+/-10%	
AIR	BALANCE		

The mixture was manufactured or transfilled from a standard which has been gravimetrically blended with traceability through NIST to the International System of Units (SI) balance. Balances are calibrated by a certified third party with certified NIST weights and NIST test numbers.**Report Number: BU70910-051123.**The uncertainty is expressed as an expanded uncertainty *U=kuc* with *uc* determined by experiment and a coverage factor *k=2*. The certified value +/-U is presented with a level of confidence of approximately 95%.

Quality Assurance Manager

APEL-RIEMER ENVIRONMENTAL, INC

REFERENCE GASES AND ATMOSPHERIC CHEMISTRY

Certificate of Analysis

Gas-phase Calibration Standard

This gas-phase standard is intended to be used as a reference material for the calibration of instruments.

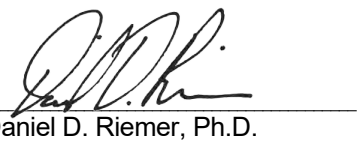
Statement about preparation and traceability:

Standards are gravimetrically prepared in high-pressure aluminum cylinders (Luxfer, Inc., Riverside, California). Cylinders are cleaned and treated to eliminate contamination and ensure inertness. Standards are prepared in N150 cylinders (~4000 Liters calibration gas), N033 cylinders (~800 Liters calibration gas), or N006 cylinders (~125 Liters calibration gas at a pressure of 2000 psia UHP nitrogen or Ultra-Pure air. Valves are high purity stainless steel (Ceodeux, Lintgen, Luxembourg) with a CGA-350 fitting. Pure compounds as liquids and gases are obtained from a number of sources. All lot numbers are cataloged. The gravimetric preparation is performed using calibrated microbalances (Mettler-Toledo, Columbus, Ohio) and microsyringes (Hamilton, Reno, Nevada and SGE, Austin, Texas) for measuring the compounds and cylinder balances (Mettler-Toledo, Columbus, Ohio) for the balance gas. Balances are calibrated with NIST traceable weights.

We prepare each cylinder individually. Accuracy is better than +/- 5%. Analysis confirms the accuracy of the gravimetric preparation. We use a series of NIST, NIST-traceable, NPL, and in-house gravimetric standards to perform the instrument calibrations.

Stability varies depending on the compound, concentration, and cylinder size. Many compounds are stable for several years.

The calibration gas mixture in cylinder D163832 is certified from the analysis date for 12 months.



Daniel D. Riemer, Ph.D.

April 26, 2023
Date

1295 NW 163rd Street, Miami, Florida 33169 USA
Telephone: 786-925-6201 / Fax: 786-364-1591
Email: info@apelriemerenvironmental.com

Cylinder: D163832
Cylinder Date: 01/23
Valve: SS CGA590 19/459478 C/R
Lot No.: 23112.1
Cylinder Pressure: 2000 psia
Analysis Date: April 26, 2023

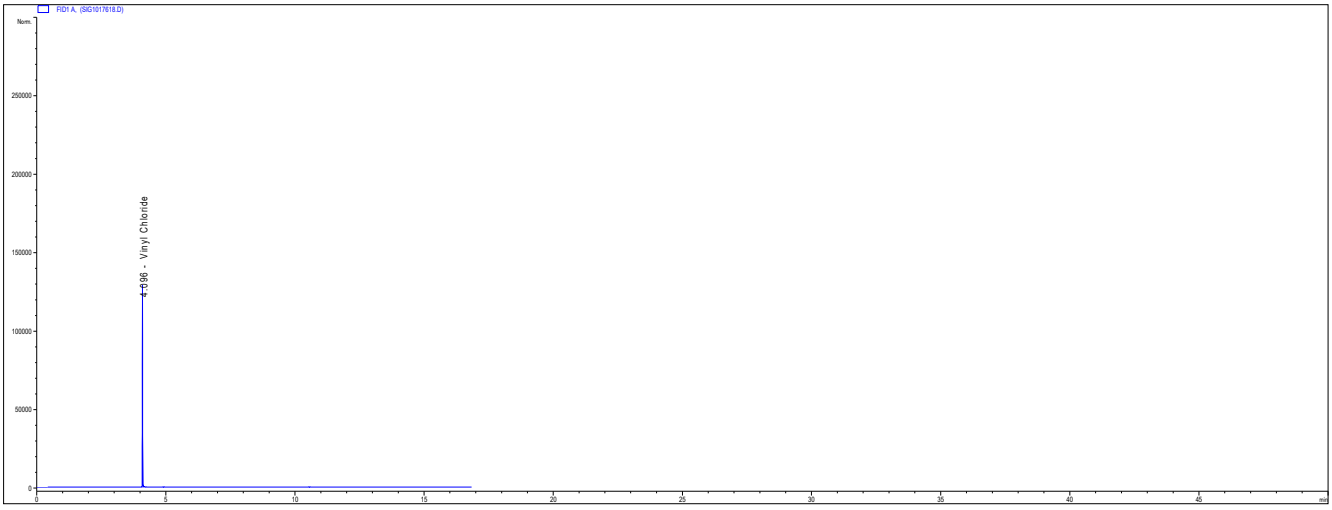
Single-component calibration mixture in ultra-pure air

Compound	CAS#	Concentration (ppb)	Uncertainty
Vinyl Chloride	75-01-4	981	±5%

Uncertainty is a conservative estimate of the combination of the uncertainties of the gravimetric preparation and analysis.

Chromatogram

100-meter DB-1, 0.25 mm id, 3.1 mL min^{-1} Helium carrier gas – constant flow
Temperature Program: 35°C, 3.5 min → 4.5°C min^{-1} → 180 °C, 6 min



APEL-RIEMER ENVIRONMENTAL, INC

REFERENCE GASES AND ATMOSPHERIC CHEMISTRY

Certificate of Analysis

Gas-phase Calibration Standard

This gas-phase standard is intended to be used as a reference material for the calibration of instruments.

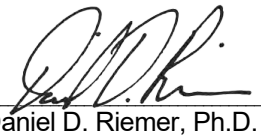
Statement about preparation and traceability:

Standards are gravimetrically prepared in high-pressure aluminum cylinders (Luxfer, Inc., Riverside, California). Cylinders are cleaned and treated to eliminate contamination and ensure inertness. Standards are prepared in N150 cylinders (~4000 Liters calibration gas), N033 cylinders (~800 Liters calibration gas), or N006 cylinders (~125 Liters calibration gas at a pressure of 2000 psia UHP nitrogen or Ultra-Pure air. Valves are high purity stainless steel (Ceodeux, Lintgen, Luxembourg) with a CGA-350 fitting. Pure compounds as liquids and gases are obtained from a number of sources. All lot numbers are cataloged. The gravimetric preparation is performed using calibrated microbalances (Mettler-Toledo, Columbus, Ohio) and microsyringes (Hamilton, Reno, Nevada and SGE, Austin, Texas) for measuring the compounds and cylinder balances (Mettler-Toledo, Columbus, Ohio) for the balance gas. Balances are calibrated with NIST traceable weights.

We prepare each cylinder individually. Accuracy is better than +/- 5%. Analysis confirms the accuracy of the gravimetric preparation. We use a series of NIST, NIST-traceable, NPL, and in-house gravimetric standards to perform the instrument calibrations.

Stability varies depending on the compound, concentration, and cylinder size. Many compounds are stable for several years.

The calibration gas mixture in cylinder D163829 is certified from the analysis date for 12 months.



Daniel D. Riemer, Ph.D.

April 26, 2023
Date

1295 NW 163rd Street, Miami, Florida 33169 USA
Telephone: 786-925-6201 / Fax: 786-364-1591
Email: info@apelriemerenvironmental.com

Cylinder: D163829
Cylinder Date: 01/23
Valve: SS CGA590 19/459481 C/R
Lot No.: 23112.2
Cylinder Pressure: 2000 psia
Analysis Date: April 26, 2023

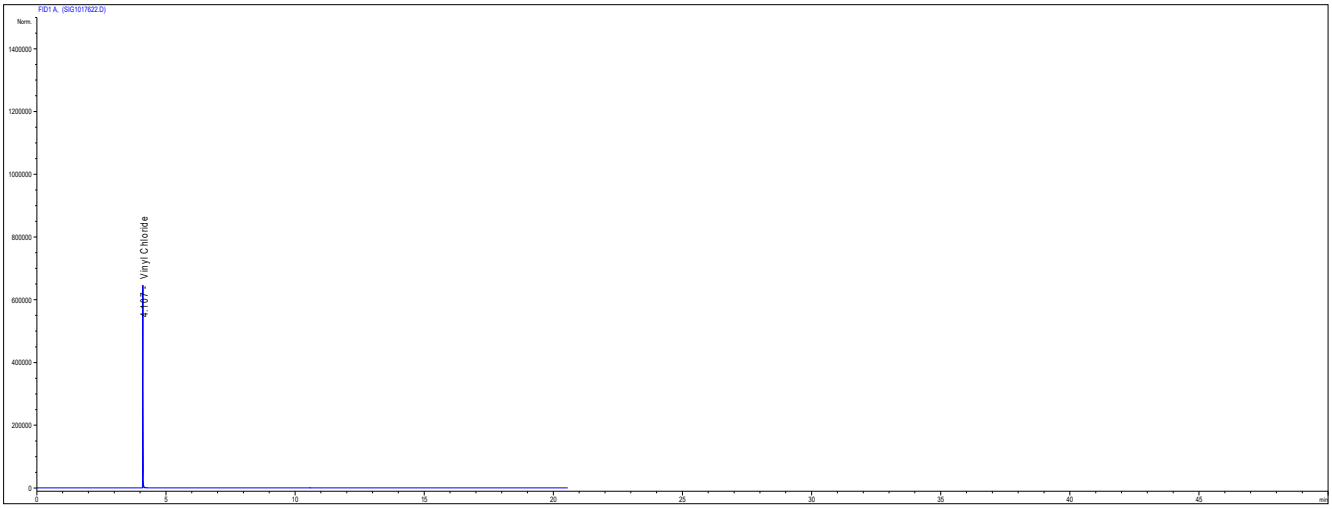
Single-component calibration mixture in ultra-pure air

Compound	CAS#	Concentration (ppb)	Uncertainty
Vinyl Chloride	75-01-4	4937	±5%

Uncertainty is a conservative estimate of the combination of the uncertainties of the gravimetric preparation and analysis.

Chromatogram

100-meter DB-1, 0.25 mm id, 3.1 mL min^{-1} Helium carrier gas – constant flow
Temperature Program: 35°C, 3.5 min → 4.5°C min^{-1} → 180 °C, 6 min



APEL-RIEMER ENVIRONMENTAL, INC

REFERENCE GASES AND ATMOSPHERIC CHEMISTRY

Certificate of Analysis

Gas-phase Calibration Standard

This gas-phase standard is intended to be used as a reference material for the calibration of instruments.

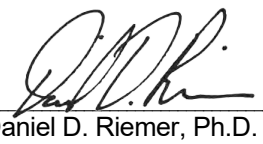
Statement about preparation and traceability:

Standards are gravimetrically prepared in high-pressure aluminum cylinders (Luxfer, Inc., Riverside, California). Cylinders are cleaned and treated to eliminate contamination and ensure inertness. Standards are prepared in N150 cylinders (~4000 Liters calibration gas), N033 cylinders (~800 Liters calibration gas), or N006 cylinders (~125 Liters calibration gas at a pressure of 2000 psia UHP nitrogen or Ultra-Pure air. Valves are high purity stainless steel (Ceodeux, Lintgen, Luxembourg) with a CGA-350 fitting. Pure compounds as liquids and gases are obtained from a number of sources. All lot numbers are cataloged. The gravimetric preparation is performed using calibrated microbalances (Mettler-Toledo, Columbus, Ohio) and microsyringes (Hamilton, Reno, Nevada and SGE, Austin, Texas) for measuring the compounds and cylinder balances (Mettler-Toledo, Columbus, Ohio) for the balance gas. Balances are calibrated with NIST traceable weights.

We prepare each cylinder individually. Accuracy is better than +/- 5%. Analysis confirms the accuracy of the gravimetric preparation. We use a series of NIST, NIST-traceable, NPL, and in-house gravimetric standards to perform the instrument calibrations.

Stability varies depending on the compound, concentration, and cylinder size. Many compounds are stable for several years.

The calibration gas mixture in cylinder D163834 is certified from the analysis date for 12 months.



Daniel D. Riemer, Ph.D.

April 26, 2023
Date

1295 NW 163rd Street, Miami, Florida 33169 USA
Telephone: 786-925-6201 / Fax: 786-364-1591
Email: info@apelriemerenvironmental.com

Cylinder: D163834
Cylinder Date: 01/23
Valve: SS CGA590 19/459466 C/R
Lot No.: 23112.3
Cylinder Pressure: 2000 psia
Analysis Date: April 26, 2023

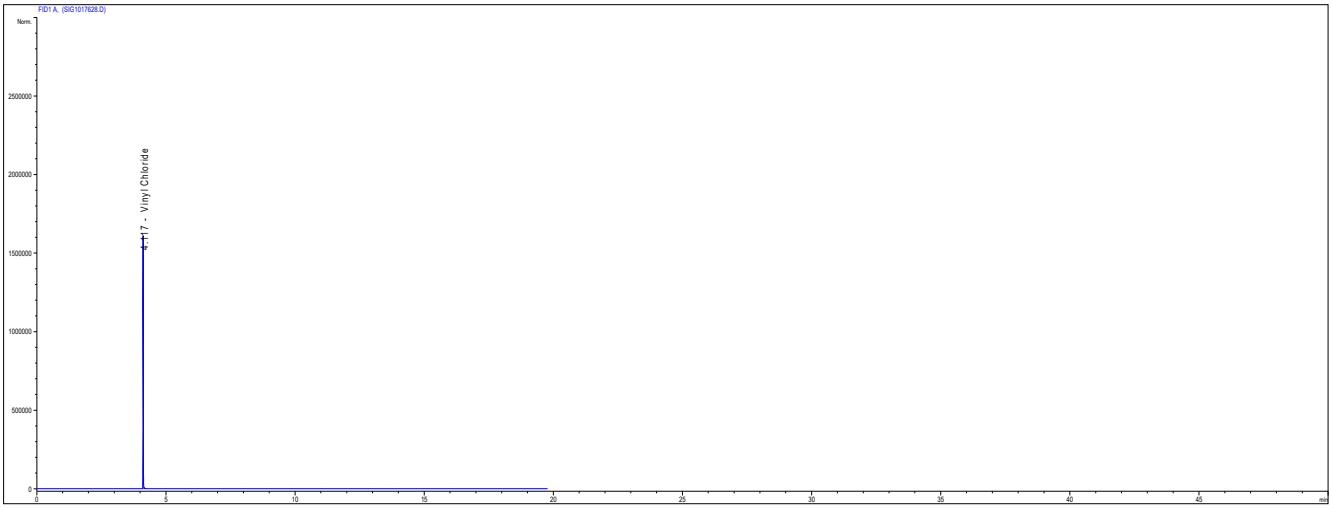
Single-component calibration mixture in ultra-pure air

Compound	CAS#	Concentration (ppb)	Uncertainty
Vinyl Chloride	75-01-4	9736	±5%

Uncertainty is a conservative estimate of the combination of the uncertainties of the gravimetric preparation and analysis.

Chromatogram

100-meter DB-1, 0.25 mm id, 3.1 mL min^{-1} Helium carrier gas – constant flow
Temperature Program: 35°C, 3.5 min → 4.5°C min^{-1} → 180 °C, 6 min



Quantitation Report (Not Reviewed)

Data Path : C:\XAVIER\DATA\APR23\X042423A\Snapshot\
Data File : X2301688.D
Acq On : 25 Apr 2023 11:24 am
Operator : TDD
[redacted] : Zero Air Cylinder
[redacted] : 500mL load
ALS Vial : 16 Sample Multiplier: 1

printout located here:
P:\Users\stg stuff

Quant Time: Apr 25 11:48:36 2023
Quant Method : C:\Xavier\methods\X100722A_TO15.M
Quant Title : TO15 TCL
QLast Update : Wed Oct 12 15:57:03 2022
Response via : Initial Calibration

Compound	R.T.	QIon	Response	Conc Units	Dev(Min)
Internal Standards					
1) Bromochloromethane (IS)	11.037	130	356158	5.21 ppbv	# 0.00
40) 1,4-Difluorobenzene (IS)	12.455	114	1355223	5.16 ppbv	0.00
52) Chlorobenzene-d5 (IS)	16.593	117	1211139	4.92 ppbv	0.00
Target Compounds					Qvalue
2) Propylene	4.328	41	972	N.D.	
3) Freon 12 (CCl2F2)	0.000		0	N.D.	
4) Freon 114 (C2Cl2F4)	0.000		0	N.D.	
5) Chloromethane	4.901	50	120	N.D.	
6) Chloroethene (Vinyl ch...	0.000		0	N.D.	
7) 1,3-Butadiene	5.338	39	448	N.D.	
8) Acetaldehyde	5.512	44	5054	0.15 ppbv #	75
9) Methanol	5.780	31	1896	0.06 ppbv #	16
10) Ethylene oxide	5.954	29	577	N.D.	
11) Bromomethane	6.035	94	104	N.D.	
12) Chloroethane	0.000		0	N.D.	
[redacted]3) Bromoethene (Vinyl bro...	0.000		0	N.D.	
14) Freon 11 (CCl3F)	0.000		0	N.D.	
15) Ethanol	7.219	45	863	0.03 ppbv #	1
16) Acrolein	7.680	56	234	N.D.	
17) Freon 113 (C2Cl3F3)	0.000		0	N.D.	
18) 1,1-Dichloroethene	7.830	61	104	N.D.	
19) Acetone	7.967	43	6251	0.05 ppbv #	100
20) Carbon disulfide	8.232	76	1420	N.D.	
21) Isopropyl alcohol	8.317	45	168	N.D.	
22) Allyl chloride (3-chlo...	0.000		0	N.D.	
23) Acetonitrile	8.416	41	172	N.D.	
24) Methylene chloride	8.698	49	2338	0.03 ppbv #	100
25) trans-1,2-Dichloroethene	0.000		0	N.D.	
26) Methyl tert-butyl ether	9.232	73	136	N.D.	
27) Acrylonitrile	0.000		0	N.D.	
28) Hexane	9.582	57	139	N.D.	
29) 1,1-Dichloroethane	0.000		0	N.D.	
30) Vinyl acetate	9.840	43	112	N.D.	
31) cis-1,2-Dichloroethylene	0.000		0	N.D.	
32) Methyl ethyl ketone (2...	0.000		0	N.D.	
33) Ethyl acetate	0.000		0	N.D.	
34) 1-Bromopropane	0.000		0	N.D.	
35) Chloroform	0.000		0	N.D.	
36) Tetrahydrofuran	0.000		0	N.D.	
37) 1,1,1-Trichloroethane	0.000		0	N.D.	
38) Cyclohexane	11.571	56	106	N.D.	
39) Carbon tetrachloride	0.000		0	N.D.	
41) Benzene	11.915	78	661	N.D.	
42) 2,2,4-Trimethylpentane	0.000		0	N.D.	
[redacted]3) 1,2-Dichloroethane	0.000		0	N.D.	
44) Heptane	0.000		0	N.D.	
45) Trichloroethene	12.811	130	145	N.D.	
46) 1,2-Dichloropropane	0.000		0	N.D.	
47) Methyl methacrylate	0.000		0	N.D.	
48) 1,4-Dioxane	0.000		0	N.D.	

49)	Bromodichloromethane	0.000		0	N.D.
50)	cis-1,3-Dichloropropene	0.000		0	N.D.
51)	Methyl isobutyl ketone	14.371	43	252	N.D.
53)	Toluene	14.598	91	508	N.D.
54)	1-Octene	0.000		0	N.D.
55)	n-Octane	0.000		0	N.D.
56)	trans-1,3-Dichloropropene	0.000		0	N.D.
57)	1,1,2-Trichloroethane	0.000		0	N.D.
58)	Tetrachloroethene	0.000		0	N.D.
59)	2-Hexanone (Methyl but...	15.488	43	276	N.D.
60)	Dibromochloromethane	0.000		0	N.D.
61)	1,2-Dibromoethane	15.954	107	136	N.D.
62)	Chlorobenzene	16.624	112	171	N.D.
63)	Ethylbenzene	16.740	91	241	N.D.
64)	1,1,1,2-Tetrachloroethane	0.000		0	N.D.
65)	m-/p-Xylenes	16.900	91	110	N.D.
66)	o-Xylene	17.477	91	244	N.D.
67)	Styrene	17.514	104	778	N.D.
68)	Bromoform	0.000		0	N.D.
69)	Isopropylbenzene	18.023	105	298	N.D.
70)	1,1,2,2-Tetrachloroethane	0.000		0	N.D.
71)	n-Propylbenzene	18.643	91	305	N.D.
72)	4-Ethyltoluene	18.809	105	116	N.D.
73)	2-Chlorotoluene	18.809	91	158	N.D.
74)	1,3,5-Trimethylbenzene	18.809	105	116	N.D.
75)	1,2,4-Trimethylbenzene	19.466	105	187	N.D.
76)	1,3-Dichlorobenzene	19.951	146	189	N.D.
77)	1,4-Dichlorobenzene	20.111	146	215	N.D.
78)	Benzyl chloride	20.264	91	112	N.D.
79)	1,2-Dichlorobenzene	0.000		0	N.D.
80)	1,2,4-Trichlorobenzene	0.000		0	N.D.
81)	Hexachlorobutadiene	23.278	225	112	N.D.
82)	Naphthalene	0.000		0	N.D.

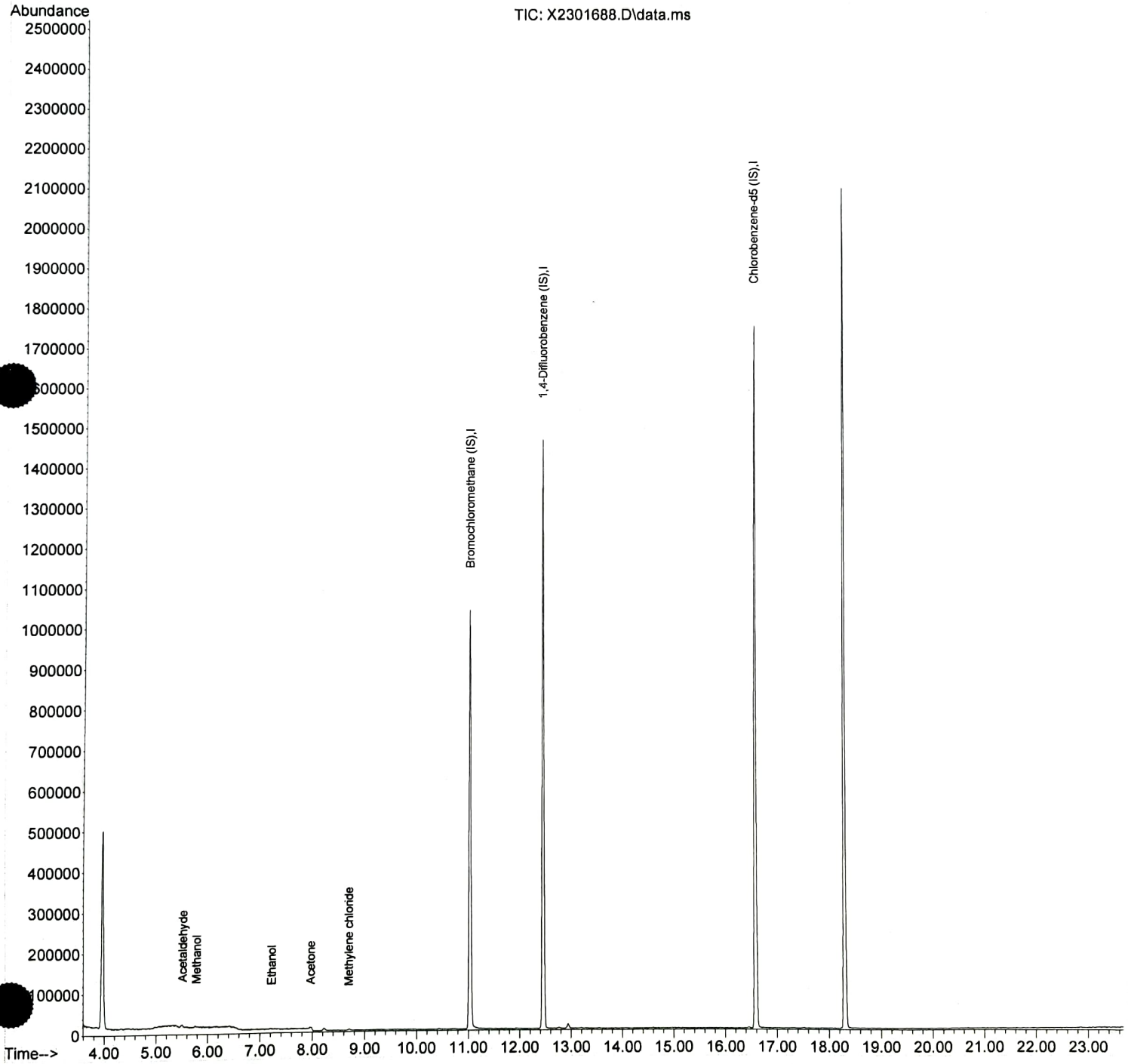
[redacted]) = qualifier out of range (m) = manual integration (+) = signals summed

X100722A_TO15.M Tue Apr 25 11:48:37 2023

Quantitation Report (Not Reviewed)

Data Path : C:\XAVIER\DATA\APR23\X042423A\Snapshot\
Data File : X2301688.D
Acq On : 25 Apr 2023 11:24 am
Operator : TDD
[redacted]mple : Zero Air Cylinder
Misc : 500mL load
ALS Vial : 16 Sample Multiplier: 1

Quant Time: Apr 25 11:48:36 2023
Quant Method : C:\Xavier\methods\X100722A_TO15.M
Quant Title : TO15 TCL
QLast Update : Wed Oct 12 15:57:03 2022
Response via : Initial Calibration



Appendix C: Test Statistics

Table C.1 Kolmogorov-Smirnov Goodness-of-Fit Test

Test Name	Instrument	Concentration	Normal Distribution p-value	Identified Distribution (alpha=0.01)	Identified Distribution p-value
Butyl Acrylate	AreaRAE Pro (PPB)	0.0 ppm	0.693578	norm	0.693578
Butyl Acrylate	AreaRAE Pro (PPB)	0.022 ppm	0.674835	norm	0.674835
Butyl Acrylate	AreaRAE Pro (PPB)	0.05 ppm	0.977474	norm	0.977474
Butyl Acrylate	AreaRAE Pro (PPB)	0.2 ppm	0.921388	norm	0.921388
Butyl Acrylate	AreaRAE Pro (PPB)	2.0 ppm	0.603422	norm	0.603422
Butyl Acrylate	AreaRAE Pro (PPB)	9.699 ppm	0.951007	norm	0.951007
Butyl Acrylate	AreaRAE (ER)	0.0 ppm	0.004307	hypsecant	0.037888
Butyl Acrylate	AreaRAE (ER)	0.2 ppm	0.159918	norm	0.159918
Butyl Acrylate	AreaRAE (ER)	2.0 ppm	0.257625	norm	0.257625
Butyl Acrylate	AreaRAE (ER)	9.699 ppm	0.655124	norm	0.655124
Butyl Acrylate	MultiRAE Pro (PPB)	0.0 ppm	0.036903	norm	0.036903
Butyl Acrylate	MultiRAE Pro (PPB)	0.022 ppm	0.304352	norm	0.304352
Butyl Acrylate	MultiRAE Pro (PPB)	0.05 ppm	0.101691	norm	0.101691
Butyl Acrylate	MultiRAE Pro (PPB)	0.2 ppm	0.804355	norm	0.804355
Butyl Acrylate	MultiRAE Pro (PPB)	2.0 ppm	0.602282	norm	0.602282
Butyl Acrylate	MultiRAE Pro (PPB)	9.699 ppm	0.610217	norm	0.610217
Butyl Acrylate	MultiRAE Pro (ER)	0.0 ppm	0.013447	norm	0.013447
Butyl Acrylate	MultiRAE Pro (ER)	0.2 ppm	0.019342	norm	0.019342
Butyl Acrylate	MultiRAE Pro (ER)	2.0 ppm	0.129965	norm	0.129965
Butyl Acrylate	MultiRAE Pro (ER)	9.699 ppm	0.303971	norm	0.303971
Butyl Acrylate	ppbRAE 3000	0.0 ppm	0.049783	norm	0.049783
Butyl Acrylate	ppbRAE 3000	0.022 ppm	0.871281	norm	0.871281
Butyl Acrylate	ppbRAE 3000	0.05 ppm	0.685527	norm	0.685527
Butyl Acrylate	ppbRAE 3000	0.2 ppm	0.970215	norm	0.970215
Butyl Acrylate	ppbRAE 3000	2.0 ppm	0.657063	norm	0.657063
Butyl Acrylate	ppbRAE 3000	9.699 ppm	0.296351	norm	0.296351
Butyl Acrylate Calibrated	AreaRAE Pro (PPB)	0.0 ppm	0.918054	norm	0.918054
Butyl Acrylate Calibrated	AreaRAE Pro (PPB)	0.022 ppm	0.873472	norm	0.873472
Butyl Acrylate Calibrated	AreaRAE Pro (PPB)	0.05 ppm	0.694806	norm	0.694806
Butyl Acrylate Calibrated	AreaRAE Pro (PPB)	0.2 ppm	0.996601	norm	0.996601
Butyl Acrylate Calibrated	AreaRAE Pro (PPB)	2.0 ppm	0.986152	norm	0.986152
Butyl Acrylate Calibrated	AreaRAE Pro (PPB)	9.699 ppm	0.662346	norm	0.662346

Table C.1 Kolmogorov-Smirnov Goodness-of-Fit Test

Test Name	Instrument	Concentration	Normal Distribution p-value	Identified Distribution (alpha=0.01)	Identified Distribution p-value
Butyl Acrylate Calibrated	AreaRAE (ER)	0.0 ppm	0.137957	norm	0.137957
Butyl Acrylate Calibrated	AreaRAE (ER)	0.2 ppm	0.306548	norm	0.306548
Butyl Acrylate Calibrated	AreaRAE (ER)	2.0 ppm	0.391350	norm	0.391350
Butyl Acrylate Calibrated	AreaRAE (ER)	9.699 ppm	0.129965	norm	0.129965
Butyl Acrylate Calibrated	MultiRAE Pro (PPB)	0.0 ppm	0.564065	norm	0.564065
Butyl Acrylate Calibrated	MultiRAE Pro (PPB)	0.022 ppm	0.828486	norm	0.828486
Butyl Acrylate Calibrated	MultiRAE Pro (PPB)	0.05 ppm	0.736277	norm	0.736277
Butyl Acrylate Calibrated	MultiRAE Pro (PPB)	0.2 ppm	0.726012	norm	0.726012
Butyl Acrylate Calibrated	MultiRAE Pro (PPB)	2.0 ppm	0.423522	norm	0.423522
Butyl Acrylate Calibrated	MultiRAE Pro (PPB)	9.699 ppm	0.864077	norm	0.864077
Butyl Acrylate Calibrated	MultiRAE Pro (ER)	0.0 ppm	0.003896	hypsecant	0.021948
Butyl Acrylate Calibrated	MultiRAE Pro (ER)	0.2 ppm	0.029119	norm	0.029119
Butyl Acrylate Calibrated	MultiRAE Pro (ER)	2.0 ppm	0.007414	logistic	0.034211
Butyl Acrylate Calibrated	MultiRAE Pro (ER)	9.699 ppm	0.500170	norm	0.500170
Butyl Acrylate Calibrated	ppbRAE 3000	0.0 ppm	None	Zero Variance	None
Butyl Acrylate Calibrated	ppbRAE 3000	0.022 ppm	0.270715	norm	0.270715
Butyl Acrylate Calibrated	ppbRAE 3000	0.05 ppm	0.343364	norm	0.343364
Butyl Acrylate Calibrated	ppbRAE 3000	0.2 ppm	0.550241	norm	0.550241
Butyl Acrylate Calibrated	ppbRAE 3000	2.0 ppm	0.696500	norm	0.696500
Butyl Acrylate Calibrated	ppbRAE 3000	9.699 ppm	0.229192	norm	0.229192
Isobutylene Calibration	AreaRAE Pro (PPB)	0 ppm	0.025536	norm	0.025536
Isobutylene Calibration	AreaRAE Pro (PPB)	10 ppm	0.908378	norm	0.908378
Isobutylene Calibration	AreaRAE Pro (PPB)	2 ppm	0.872317	norm	0.872317
Isobutylene Calibration	AreaRAE (ER)	0 ppm	0.000000	vonmises_line	0.000005
Isobutylene Calibration	AreaRAE (ER)	10 ppm	0.344896	norm	0.344896
Isobutylene Calibration	AreaRAE (ER)	2 ppm	0.628901	norm	0.628901
Isobutylene Calibration	MultiRAE Pro (PPB)	0 ppm	0.002304	dweibull	0.025898
Isobutylene Calibration	MultiRAE Pro (PPB)	10 ppm	0.108560	norm	0.108560
Isobutylene Calibration	MultiRAE Pro (PPB)	2 ppm	0.287742	norm	0.287742
Isobutylene Calibration	MultiRAE Pro (ER)	0 ppm	0.000000	vonmises_line	0.000005
Isobutylene Calibration	MultiRAE Pro (ER)	10 ppm	0.437429	norm	0.437429
Isobutylene Calibration	MultiRAE Pro (ER)	2 ppm	0.001440	chi	0.001704

Table C.1 Kolmogorov-Smirnov Goodness-of-Fit Test

Test Name	Instrument	Concentration	Normal Distribution p-value	Identified Distribution (alpha=0.01)	Identified Distribution p-value
Isobutylene Calibration	ppbRAE 3000	0 ppm	0.000050	gumbel_l	0.000171
Isobutylene Calibration	ppbRAE 3000	10 ppm	0.720444	norm	0.720444
Isobutylene Calibration	ppbRAE 3000	2 ppm	0.112670	norm	0.112670
Isobutylene	AreaRAE Pro (PPB)	0 ppm	0.025536	norm	0.025536
Isobutylene	AreaRAE Pro (PPB)	10 ppm	0.908378	norm	0.908378
Isobutylene	AreaRAE Pro (PPB)	100 ppm	0.362917	norm	0.362917
Isobutylene	AreaRAE Pro (PPB)	2 ppm	0.872317	norm	0.872317
Isobutylene	AreaRAE (ER)	0 ppm	0.000000	vonmises_line	0.000005
Isobutylene	AreaRAE (ER)	10 ppm	0.344896	norm	0.344896
Isobutylene	AreaRAE (ER)	100 ppm	0.789583	norm	0.789583
Isobutylene	AreaRAE (ER)	2 ppm	0.628901	norm	0.628901
Isobutylene	MultiRAE Pro (PPB)	0 ppm	0.002304	dweibull	0.025898
Isobutylene	MultiRAE Pro (PPB)	10 ppm	0.108560	norm	0.108560
Isobutylene	MultiRAE Pro (PPB)	100 ppm	0.662214	norm	0.662214
Isobutylene	MultiRAE Pro (PPB)	2 ppm	0.287742	norm	0.287742
Isobutylene	MultiRAE Pro (ER)	0 ppm	0.000000	vonmises_line	0.000005
Isobutylene	MultiRAE Pro (ER)	10 ppm	0.437429	norm	0.437429
Isobutylene	MultiRAE Pro (ER)	100 ppm	0.243614	norm	0.243614
Isobutylene	MultiRAE Pro (ER)	2 ppm	0.001440	chi	0.001704
Isobutylene	ppbRAE 3000	0 ppm	0.000050	gumbel_l	0.000171
Isobutylene	ppbRAE 3000	10 ppm	0.720444	norm	0.720444
Isobutylene	ppbRAE 3000	100 ppm	0.576235	norm	0.576235
Isobutylene	ppbRAE 3000	2 ppm	0.112670	norm	0.112670
Vinyl Chloride	AreaRAE Pro (PPB)	0.0 ppm	0.671106	norm	0.671106
Vinyl Chloride	AreaRAE Pro (PPB)	0.05 ppm	0.906821	norm	0.906821
Vinyl Chloride	AreaRAE Pro (PPB)	0.2 ppm	0.848549	norm	0.848549
Vinyl Chloride	AreaRAE Pro (PPB)	0.981 ppm	0.674127	norm	0.674127
Vinyl Chloride	AreaRAE Pro (PPB)	4.937 ppm	0.725946	norm	0.725946
Vinyl Chloride	AreaRAE Pro (PPB)	9.736 ppm	0.803489	norm	0.803489
Vinyl Chloride	AreaRAE (ER)	0.0 ppm	None	Zero Variance	None
Vinyl Chloride	AreaRAE (ER)	0.2 ppm	0.306548	norm	0.306548
Vinyl Chloride	AreaRAE (ER)	0.981 ppm	0.683485	norm	0.683485

Table C.1 Kolmogorov-Smirnov Goodness-of-Fit Test

Test Name	Instrument	Concentration	Normal Distribution p-value	Identified Distribution (alpha=0.01)	Identified Distribution p-value
Vinyl Chloride	AreaRAE (ER)	4.937 ppm	0.691189	norm	0.691189
Vinyl Chloride	AreaRAE (ER)	9.736 ppm	0.437552	norm	0.437552
Vinyl Chloride	MultiRAE Pro (PPB)	0.0 ppm	0.000858	halfcauchy	0.009840
Vinyl Chloride	MultiRAE Pro (PPB)	0.05 ppm	0.247616	norm	0.247616
Vinyl Chloride	MultiRAE Pro (PPB)	0.2 ppm	0.857284	norm	0.857284
Vinyl Chloride	MultiRAE Pro (PPB)	0.981 ppm	0.664901	norm	0.664901
Vinyl Chloride	MultiRAE Pro (PPB)	4.937 ppm	0.569467	norm	0.569467
Vinyl Chloride	MultiRAE Pro (PPB)	9.736 ppm	0.951260	norm	0.951260
Vinyl Chloride	MultiRAE Pro (ER)	0.0 ppm	0.000275	burr12	0.004074
Vinyl Chloride	MultiRAE Pro (ER)	0.2 ppm	None	Zero Variance	None
Vinyl Chloride	MultiRAE Pro (ER)	0.981 ppm	None	Zero Variance	None
Vinyl Chloride	MultiRAE Pro (ER)	4.937 ppm	None	Zero Variance	None
Vinyl Chloride	MultiRAE Pro (ER)	9.736 ppm	0.415516	norm	0.415516
Vinyl Chloride	ppbRAE 3000	0.0 ppm	0.000019	logistic	0.000312
Vinyl Chloride	ppbRAE 3000	0.05 ppm	0.581931	norm	0.581931
Vinyl Chloride	ppbRAE 3000	0.2 ppm	0.877287	norm	0.877287
Vinyl Chloride	ppbRAE 3000	0.981 ppm	0.033526	norm	0.033526
Vinyl Chloride	ppbRAE 3000	4.937 ppm	0.533914	norm	0.533914
Vinyl Chloride	ppbRAE 3000	9.736 ppm	0.850417	norm	0.850417
Vinyl Chloride Post BA	AreaRAE Pro (PPB)	0.0 ppm	0.004649	cauchy	0.025173
Vinyl Chloride Post BA	AreaRAE Pro (PPB)	0.05 ppm	0.701449	norm	0.701449
Vinyl Chloride Post BA	AreaRAE Pro (PPB)	0.2 ppm	0.891081	norm	0.891081
Vinyl Chloride Post BA	AreaRAE Pro (PPB)	0.981 ppm	0.518536	norm	0.518536
Vinyl Chloride Post BA	AreaRAE Pro (PPB)	4.937 ppm	0.775913	norm	0.775913
Vinyl Chloride Post BA	AreaRAE Pro (PPB)	9.736 ppm	0.784158	norm	0.784158
Vinyl Chloride Post BA	AreaRAE (ER)	0.0 ppm	0.013447	norm	0.013447
Vinyl Chloride Post BA	AreaRAE (ER)	0.2 ppm	0.019342	norm	0.019342
Vinyl Chloride Post BA	AreaRAE (ER)	0.981 ppm	0.064800	norm	0.064800
Vinyl Chloride Post BA	AreaRAE (ER)	4.937 ppm	0.687299	norm	0.687299
Vinyl Chloride Post BA	AreaRAE (ER)	9.736 ppm	0.616773	norm	0.616773
Vinyl Chloride Post BA	MultiRAE Pro (PPB)	0.0 ppm	0.762411	norm	0.762411
Vinyl Chloride Post BA	MultiRAE Pro (PPB)	0.05 ppm	0.698878	norm	0.698878

Table C.1 Kolmogorov-Smirnov Goodness-of-Fit Test

Test Name	Instrument	Concentration	Normal Distribution p-value	Identified Distribution (alpha=0.01)	Identified Distribution p-value
Vinyl Chloride Post BA	MultiRAE Pro (PPB)	0.2 ppm	0.965764	norm	0.965764
Vinyl Chloride Post BA	MultiRAE Pro (PPB)	0.981 ppm	0.638239	norm	0.638239
Vinyl Chloride Post BA	MultiRAE Pro (PPB)	4.937 ppm	0.705544	norm	0.705544
Vinyl Chloride Post BA	MultiRAE Pro (PPB)	9.736 ppm	0.988618	norm	0.988618
Vinyl Chloride Post BA	MultiRAE Pro (ER)	0.0 ppm	0.000726	vonmises_line	0.008675
Vinyl Chloride Post BA	MultiRAE Pro (ER)	0.2 ppm	0.007414	logistic	0.034211
Vinyl Chloride Post BA	MultiRAE Pro (ER)	0.981 ppm	0.019342	norm	0.019342
Vinyl Chloride Post BA	MultiRAE Pro (ER)	4.937 ppm	None	Zero Variance	None
Vinyl Chloride Post BA	MultiRAE Pro (ER)	9.736 ppm	0.427814	norm	0.427814
Vinyl Chloride Post BA	ppbRAE 3000	0.0 ppm	None	Zero Variance	None
Vinyl Chloride Post BA	ppbRAE 3000	0.05 ppm	0.658839	norm	0.658839
Vinyl Chloride Post BA	ppbRAE 3000	0.2 ppm	0.804192	norm	0.804192
Vinyl Chloride Post BA	ppbRAE 3000	0.981 ppm	0.732919	norm	0.732919
Vinyl Chloride Post BA	ppbRAE 3000	4.937 ppm	0.973286	norm	0.973286
Vinyl Chloride Post BA	ppbRAE 3000	9.736 ppm	0.898471	norm	0.898471

Where the variance of the dataset was zero, the distribution is None.

========== Butyl Acrylate AreaRAE (ER) Statistics ==========

Date: 2023-05-06
Start: 08:48:18
Stop: 10:26:45

NOTE: VALUES WHICH HAVE THE ABREVIATION "MFG." HAVE THE MANUFACTURER CORRECTION FACTOR APPLIED TO THE VALUE.

########## Regression Statistics ##########
n: 45
Mean Percent Error (Mfg.): 19.36
Mean Percent Error (Assessment): 35.237
% Relative Standard Deviation (x): 156.993
% Relative Standard Deviation (y): 151.491
Standard Deviation (x): 3.736
Standard Deviation (y): 1.946
Variance (x): 13.959
Variance (y): 3.786
Covariance (xy): 7.335
Alpha: 0.05
df: (n - 2) = 43
t-value: 2.017
Correlation Coefficient (R): 0.987
R^2: 0.973
MSE (yh): 0.101
Slope: 0.514
Slope Standard Error: 0.013
Slope p-value: 1.9322409025499138e-35 (Ho: slope = 0)
y-Intercept: 0.062
y-Intercept Standard Error: 0.058
Regression Equation: y = 0.514(x) + 0.062
Confidence Interval (Slope): 0.514 +/- 0.026
UCL (Slope): 0.54
LCL (Slope): 0.488
Honeywell Correction Factor: 1.6
Isobutylene Calibration Slope: 0.996
Assessment Correction Factor: 1.938
##########

```
########## Target 0.0 ppm Statistics ##########
n: 18
Min (y): 0.0
Max (y): 0.1
Mean (y): 0.061
Mean Corrected Mfg. (y): 0.098
Median (y): 0.1
Sample Standard Deviation (y): 0.049
Variance (y): 0.002
Mean Percent Error Mfg. (y): nan
% Relative Standard Deviation (y): 79.772
MSE: 0.016
Alpha: 0.05
df: (n - 2) = 16
t-value: 2.12
Confidence Interval (y): 0.061 +/- 0.024
Confidence Interval Corrected Mfg. (y): 0.098 +/- 0.039
UCL: 0.085
UCL Mfg. Corrected: 0.137
LCL: 0.037
LCL Mfg. Corrected: 0.059
Prediction Interval (y): 0.061 +/- 0.106
One-sample Mfg. t-test: t-statistic Mfg.=5.169, p-value=7.712581804965855e-05
             Reject Mfg. Ho (ymean = u): True
################################################

########## Target 0.2 ppm Statistics ##########
n: 9
Min (y): 0.1
Max (y): 0.3
Mean (y): 0.211
Mean Corrected Mfg. (y): 0.338
Median (y): 0.2
Sample Standard Deviation (y): 0.057
Variance (y): 0.003
Mean Percent Error Mfg. (y): 68.889
% Relative Standard Deviation (y): 26.837
MSE: 0.027
Alpha: 0.05
df: (n - 2) = 7
t-value: 2.365
Confidence Interval (y): 0.211 +/- 0.045
Confidence Interval Corrected Mfg. (y): 0.338 +/- 0.071
UCL: 0.256
UCL Mfg. Corrected: 0.409
LCL: 0.166
LCL Mfg. Corrected: 0.267
Prediction Interval (y): 0.211 +/- 0.141
One-sample Mfg. t-test: t-statistic Mfg.=4.299, p-value=0.002619553439705576
             Reject Mfg. Ho (ymean = u): True
################################################
```

```
########## Target 2.0 ppm Statistics ##########
n: 9
Min (y): 0.8
Max (y): 1.2
Mean (y): 1.033
Mean Corrected Mfg. (y): 1.653
Median (y): 1.1
Sample Standard Deviation (y): 0.17
Variance (y): 0.029
Mean Percent Error Mfg. (y): -17.333
% Relative Standard Deviation (y): 16.448
MSE: 0.194
Alpha: 0.05
df: (n - 2) = 7
t-value: 2.365
Confidence Interval (y): 1.033 +/- 0.134
Confidence Interval Corrected Mfg. (y): 1.653 +/- 0.214
UCL: 1.167
UCL Mfg. Corrected: 1.867
LCL: 0.899
LCL Mfg. Corrected: 1.439
Prediction Interval (y): 1.033 +/- 0.424
One-sample Mfg. t-test: t-statistic Mfg.=-3.606, p-value=0.006926247902459686
             Reject Mfg. Ho (ymean = u): True
################################################

########## Target 9.699 ppm Statistics ##########
n: 9
Min (y): 4.2
Max (y): 5.9
Mean (y): 5.056
Mean Corrected Mfg. (y): 8.089
Median (y): 5.1
Sample Standard Deviation (y): 0.682
Variance (y): 0.465
Mean Percent Error Mfg. (y): -16.601
% Relative Standard Deviation (y): 13.484
MSE: 3.782
Alpha: 0.05
df: (n - 2) = 7
t-value: 2.365
Confidence Interval (y): 5.056 +/- 0.537
Confidence Interval Corrected Mfg. (y): 8.089 +/- 0.86
UCL: 5.593
UCL Mfg. Corrected: 8.949
LCL: 4.519
LCL Mfg. Corrected: 7.229
Prediction Interval (y): 5.056 +/- 1.699
One-sample Mfg. t-test: t-statistic Mfg.=-4.175, p-value=0.0030990635712228494
             Reject Mfg. Ho (ymean = u): True
################################################
```

========== Butyl Acrylate AreaRAE Pro (PPB) Statistics ==========

Date: 2023-05-04
Start: 10:55:40
Stop: 12:22:00

NOTE: VALUES WHICH HAVE THE ABREVIATION "MFG." HAVE THE MANUFACTURER CORRECTION FACTOR APPLIED TO THE VALUE.

########## Regression Statistics ##########
n: 57
Mean Percent Error (Mfg.): -192.199
Mean Percent Error (Assessment): 138.845
% Relative Standard Deviation (x): 182.65
% Relative Standard Deviation (y): 168.768
Standard Deviation (x): 3.452
Standard Deviation (y): 2.042
Variance (x): 11.919
Variance (y): 4.171
Covariance (xy): 7.174
Alpha: 0.05
df: (n - 2) = 55
t-value: 2.004
Correlation Coefficient (R): 1.0
R^2: 0.999
MSE (yh): 0.004
Slope: 0.591
Slope Standard Error: 0.002
Slope p-value: 1.2627680203818137e-85 (Ho: slope = 0)
y-Intercept: 0.092
y-Intercept Standard Error: 0.009
Regression Equation: y = 0.591(x) + 0.092
Confidence Interval (Slope): 0.591 +/- 0.005
UCL (Slope): 0.596
LCL (Slope): 0.586
Honeywell Correction Factor: 1.6
Isobutylene Calibration Slope: 0.981
Assessment Correction Factor: 1.66
##

```
########## Target 0.0 ppm Statistics ##########
n: 12
Min (y): 0.0
Max (y): 0.23
Mean (y): 0.125
Mean Corrected Mfg. (y): 0.2
Median (y): 0.15
Sample Standard Deviation (y): 0.079
Variance (y): 0.006
Mean Percent Error Mfg. (y): nan
% Relative Standard Deviation (y): 63.203
MSE: 0.056
Alpha: 0.05
df: (n - 2) = 10
t-value: 2.228
Confidence Interval (y): 0.125 +/- 0.051
Confidence Interval Corrected Mfg. (y): 0.2 +/- 0.081
UCL: 0.176
UCL Mfg. Corrected: 0.281
LCL: 0.074
LCL Mfg. Corrected: 0.119
Prediction Interval (y): 0.125 +/- 0.183
One-sample Mfg. t-test: t-statistic Mfg.=5.248, p-value=0.00027362044427562657
             Reject Mfg. Ho (ymean = u): True
################################################

########## Target 0.022 ppm Statistics ##########
n: 9
Min (y): 0.0
Max (y): 0.16
Mean (y): 0.068
Mean Corrected Mfg. (y): 0.108
Median (y): 0.08
Sample Standard Deviation (y): 0.055
Variance (y): 0.003
Mean Percent Error Mfg. (y): 392.929
% Relative Standard Deviation (y): 81.044
MSE: 0.015
Alpha: 0.05
df: (n - 2) = 7
t-value: 2.365
Confidence Interval (y): 0.068 +/- 0.043
Confidence Interval Corrected Mfg. (y): 0.108 +/- 0.069
UCL: 0.111
UCL Mfg. Corrected: 0.177
LCL: 0.025
LCL Mfg. Corrected: 0.039
Prediction Interval (y): 0.068 +/- 0.137
One-sample Mfg. t-test: t-statistic Mfg.=2.782, p-value=0.023851579519368143
             Reject Mfg. Ho (ymean = u): True
################################################
```

```
########## Target 0.05 ppm Statistics ##########
n: 9
Min (y): 0.01
Max (y): 0.16
Mean (y): 0.088
Mean Corrected Mfg. (y): 0.14
Median (y): 0.08
Sample Standard Deviation (y): 0.042
Variance (y): 0.002
Mean Percent Error Mfg. (y): 180.889
% Relative Standard Deviation (y): 48.268
MSE: 0.013
Alpha: 0.05
df: (n - 2) = 7
t-value: 2.365
Confidence Interval (y): 0.088 +/- 0.033
Confidence Interval Corrected Mfg. (y): 0.14 +/- 0.053
UCL: 0.121
UCL Mfg. Corrected: 0.193
LCL: 0.055
LCL Mfg. Corrected: 0.087
Prediction Interval (y): 0.088 +/- 0.106
One-sample Mfg. t-test: t-statistic Mfg.=3.774, p-value=0.00543684354497788
             Reject Mfg. Ho (ymean = u): True
################################################

########## Target 0.2 ppm Statistics ##########
n: 9
Min (y): 0.19
Max (y): 0.25
Mean (y): 0.222
Mean Corrected Mfg. (y): 0.356
Median (y): 0.22
Sample Standard Deviation (y): 0.02
Variance (y): 0.0
Mean Percent Error Mfg. (y): 77.778
% Relative Standard Deviation (y): 9.192
MSE: 0.025
Alpha: 0.05
df: (n - 2) = 7
t-value: 2.365
Confidence Interval (y): 0.222 +/- 0.016
Confidence Interval Corrected Mfg. (y): 0.356 +/- 0.026
UCL: 0.238
UCL Mfg. Corrected: 0.382
LCL: 0.206
LCL Mfg. Corrected: 0.33
Prediction Interval (y): 0.222 +/- 0.051
One-sample Mfg. t-test: t-statistic Mfg.=13.462, p-value=8.889844950718889e-07
             Reject Mfg. Ho (ymean = u): True
################################################
```

```
########## Target 2.0 ppm Statistics ##########
n: 9
Min (y): 1.24
Max (y): 1.36
Mean (y): 1.297
Mean Corrected Mfg. (y): 2.075
Median (y): 1.28
Sample Standard Deviation (y): 0.035
Variance (y): 0.001
Mean Percent Error Mfg. (y): 3.733
% Relative Standard Deviation (y): 2.696
MSE: 0.009
Alpha: 0.05
df: (n - 2) = 7
t-value: 2.365
Confidence Interval (y): 1.297 +/- 0.028
Confidence Interval Corrected Mfg. (y): 2.075 +/- 0.044
UCL: 1.325
UCL Mfg. Corrected: 2.119
LCL: 1.269
LCL Mfg. Corrected: 2.031
Prediction Interval (y): 1.297 +/- 0.087
One-sample Mfg. t-test: t-statistic Mfg.=3.776, p-value=0.00542272644259285
             Reject Mfg. Ho (ymean = u): True
################################################

########## Target 9.699 ppm Statistics ##########
n: 9
Min (y): 5.71
Max (y): 5.91
Mean (y): 5.823
Mean Corrected Mfg. (y): 9.317
Median (y): 5.84
Sample Standard Deviation (y): 0.064
Variance (y): 0.004
Mean Percent Error Mfg. (y): -3.935
% Relative Standard Deviation (y): 1.092
MSE: 0.156
Alpha: 0.05
df: (n - 2) = 7
t-value: 2.365
Confidence Interval (y): 5.823 +/- 0.05
Confidence Interval Corrected Mfg. (y): 9.317 +/- 0.08
UCL: 5.873
UCL Mfg. Corrected: 9.397
LCL: 5.773
LCL Mfg. Corrected: 9.237
Prediction Interval (y): 5.823 +/- 0.159
One-sample Mfg. t-test: t-statistic Mfg.=-10.609, p-value=5.449577895402745e-06
             Reject Mfg. Ho (ymean = u): True
################################################
```

============= Butyl Acrylate Calibrated AreaRAE (ER) Statistics =============

Date: 2023-05-06
Start: 10:37:58
Stop: 12:49:31

NOTE: VALUES WHICH HAVE THE ABREVIATION "MFG." HAVE THE MANUFACTURER
CORRECTION FACTOR APPLIED TO THE VALUE.

########## Regression Statistics ##########
n: 42
Mean Percent Error (Mfg.): 20.238
Mean Percent Error (Assessment): 36.111
% Relative Standard Deviation (x): 149.456
% Relative Standard Deviation (y): 142.832
Standard Deviation (x): 3.811
Standard Deviation (y): 3.856
Variance (x): 14.522
Variance (y): 14.872
Covariance (xy): 15.05
Alpha: 0.05
df: (n - 2) = 40
t-value: 2.021
Correlation Coefficient (R): 1.0
R^2: 0.999
MSE (yh): 0.01
Slope: 1.012
Slope Standard Error: 0.004
Slope p-value: 2.0640882155748775e-65 (Ho: slope = 0)
y-Intercept: 0.12
y-Intercept Standard Error: 0.019
Regression Equation: y = 1.012(x) + 0.12
Confidence Interval (Slope): 1.012 +/- 0.008
UCL (Slope): 1.02
LCL (Slope): 1.004
Honeywell Correction Factor: 1.0
Isobutylene Calibration Slope: 0.996
Assessment Correction Factor: 0.984
##

```
########## Target 0.0 ppm Statistics ##########
n: 15
Min (y): 0.0
Max (y): 0.2
Mean (y): 0.12
Mean Corrected Mfg. (y): 0.12
Median (y): 0.1
Sample Standard Deviation (y): 0.065
Variance (y): 0.004
Mean Percent Error Mfg. (y): nan
% Relative Standard Deviation (y): 54.433
MSE: 0.019
Alpha: 0.05
df: (n - 2) = 13
t-value: 2.16
Confidence Interval (y): 0.12 +/- 0.036
Confidence Interval Corrected Mfg. (y): 0.12 +/- 0.036
UCL: 0.156
UCL Mfg. Corrected: 0.156
LCL: 0.084
LCL Mfg. Corrected: 0.084
Prediction Interval (y): 0.12 +/- 0.146
One-sample Mfg. t-test: t-statistic Mfg.=6.874, p-value=7.636462972387166e-06
             Reject Mfg. Ho (ymean = u): True
################################################

########## Target 0.2 ppm Statistics ##########
n: 9
Min (y): 0.3
Max (y): 0.5
Mean (y): 0.422
Mean Corrected Mfg. (y): 0.422
Median (y): 0.4
Sample Standard Deviation (y): 0.063
Variance (y): 0.004
Mean Percent Error Mfg. (y): 111.111
% Relative Standard Deviation (y): 14.886
MSE: 0.053
Alpha: 0.05
df: (n - 2) = 7
t-value: 2.365
Confidence Interval (y): 0.422 +/- 0.05
Confidence Interval Corrected Mfg. (y): 0.422 +/- 0.05
UCL: 0.472
UCL Mfg. Corrected: 0.472
LCL: 0.372
LCL Mfg. Corrected: 0.372
Prediction Interval (y): 0.422 +/- 0.157
One-sample Mfg. t-test: t-statistic Mfg.=10.0, p-value=8.488181527628484e-06
             Reject Mfg. Ho (ymean = u): True
################################################
```

```
########## Target 2.0 ppm Statistics ##########
n: 9
Min (y): 1.9
Max (y): 2.1
Mean (y): 2.022
Mean Corrected Mfg. (y): 2.022
Median (y): 2.0
Sample Standard Deviation (y): 0.079
Variance (y): 0.006
Mean Percent Error Mfg. (y): 1.111
% Relative Standard Deviation (y): 3.885
MSE: 0.007
Alpha: 0.05
df: (n - 2) = 7
t-value: 2.365
Confidence Interval (y): 2.022 +/- 0.062
Confidence Interval Corrected Mfg. (y): 2.022 +/- 0.062
UCL: 2.084
UCL Mfg. Corrected: 2.084
LCL: 1.96
LCL Mfg. Corrected: 1.96
Prediction Interval (y): 2.022 +/- 0.196
One-sample Mfg. t-test: t-statistic Mfg.=0.8, p-value=0.44681333411491053
             Reject Mfg. Ho (ymean = u): False
################################################

########## Target 9.699 ppm Statistics ##########
n: 9
Min (y): 9.9
Max (y): 10.0
Mean (y): 9.956
Mean Corrected Mfg. (y): 9.956
Median (y): 10.0
Sample Standard Deviation (y): 0.05
Variance (y): 0.002
Mean Percent Error Mfg. (y): 2.645
% Relative Standard Deviation (y): 0.499
MSE: 0.068
Alpha: 0.05
df: (n - 2) = 7
t-value: 2.365
Confidence Interval (y): 9.956 +/- 0.039
Confidence Interval Corrected Mfg. (y): 9.956 +/- 0.039
UCL: 9.995
UCL Mfg. Corrected: 9.995
LCL: 9.917
LCL Mfg. Corrected: 9.917
Prediction Interval (y): 9.956 +/- 0.124
One-sample Mfg. t-test: t-statistic Mfg.=14.603, p-value=4.742332902598759e-07
             Reject Mfg. Ho (ymean = u): True
################################################
```

========== Butyl Acrylate Calibrated AreaRAE Pro (PPB) Statistics ==========

Date: 2023-05-04
Start: 13:28:00
Stop: 15:12:00

NOTE: VALUES WHICH HAVE THE ABREVIATION "MFG." HAVE THE MANUFACTURER CORRECTION FACTOR APPLIED TO THE VALUE.

########## Regression Statistics ##########
n: 57
Mean Percent Error (Mfg.): -77.93
Mean Percent Error (Assessment): 250.978
% Relative Standard Deviation (x): 182.65
% Relative Standard Deviation (y): 163.991
Standard Deviation (x): 3.452
Standard Deviation (y): 3.523
Variance (x): 11.919
Variance (y): 12.413
Covariance (xy): 12.377
Alpha: 0.05
df: (n - 2) = 55
t-value: 2.004
Correlation Coefficient (R): 1.0
R^2: 0.999
MSE (yh): 0.007
Slope: 1.02
Slope Standard Error: 0.003
Slope p-value: 8.687580246193686e-91 (Ho: slope = 0)
y-Intercept: 0.22
y-Intercept Standard Error: 0.013
Regression Equation: y = 1.02(x) + 0.22
Confidence Interval (Slope): 1.02 +/- 0.007
UCL (Slope): 1.027
LCL (Slope): 1.013
Honeywell Correction Factor: 1.0
Isobutylene Calibration Slope: 0.981
Assessment Correction Factor: 0.962
##

```
########## Target 0.0 ppm Statistics ##########
n: 12
Min (y): 0.14
Max (y): 0.38
Mean (y): 0.258
Mean Corrected Mfg. (y): 0.258
Median (y): 0.255
Sample Standard Deviation (y): 0.074
Variance (y): 0.005
Mean Percent Error Mfg. (y): nan
% Relative Standard Deviation (y): 28.701
MSE: 0.072
Alpha: 0.05
df: (n - 2) = 10
t-value: 2.228
Confidence Interval (y): 0.258 +/- 0.048
Confidence Interval Corrected Mfg. (y): 0.258 +/- 0.048
UCL: 0.306
UCL Mfg. Corrected: 0.306
LCL: 0.21
LCL Mfg. Corrected: 0.21
Prediction Interval (y): 0.258 +/- 0.172
One-sample Mfg. t-test: t-statistic Mfg.=11.556, p-value=1.7123407396307205e-07
             Reject Mfg. Ho (ymean = u): True
################################################

########## Target 0.022 ppm Statistics ##########
n: 9
Min (y): 0.12
Max (y): 0.26
Mean (y): 0.19
Mean Corrected Mfg. (y): 0.19
Median (y): 0.19
Sample Standard Deviation (y): 0.048
Variance (y): 0.002
Mean Percent Error Mfg. (y): 763.636
% Relative Standard Deviation (y): 25.423
MSE: 0.031
Alpha: 0.05
df: (n - 2) = 7
t-value: 2.365
Confidence Interval (y): 0.19 +/- 0.038
Confidence Interval Corrected Mfg. (y): 0.19 +/- 0.038
UCL: 0.228
UCL Mfg. Corrected: 0.228
LCL: 0.152
LCL Mfg. Corrected: 0.152
Prediction Interval (y): 0.19 +/- 0.12
One-sample Mfg. t-test: t-statistic Mfg.=9.837, p-value=9.594430879347313e-06
             Reject Mfg. Ho (ymean = u): True
################################################
```

```
########## Target 0.05 ppm Statistics ##########
n: 9
Min (y): 0.19
Max (y): 0.31
Mean (y): 0.264
Mean Corrected Mfg. (y): 0.264
Median (y): 0.28
Sample Standard Deviation (y): 0.041
Variance (y): 0.002
Mean Percent Error Mfg. (y): 428.889
% Relative Standard Deviation (y): 15.449
MSE: 0.048
Alpha: 0.05
df: (n - 2) = 7
t-value: 2.365
Confidence Interval (y): 0.264 +/- 0.032
Confidence Interval Corrected Mfg. (y): 0.264 +/- 0.032
UCL: 0.296
UCL Mfg. Corrected: 0.296
LCL: 0.232
LCL Mfg. Corrected: 0.232
Prediction Interval (y): 0.264 +/- 0.102
One-sample Mfg. t-test: t-statistic Mfg.=14.846, p-value=4.173953098266133e-07
             Reject Mfg. Ho (ymean = u): True
################################################

########## Target 0.2 ppm Statistics ##########
n: 9
Min (y): 0.34
Max (y): 0.53
Mean (y): 0.429
Mean Corrected Mfg. (y): 0.429
Median (y): 0.42
Sample Standard Deviation (y): 0.053
Variance (y): 0.003
Mean Percent Error Mfg. (y): 114.444
% Relative Standard Deviation (y): 12.457
MSE: 0.055
Alpha: 0.05
df: (n - 2) = 7
t-value: 2.365
Confidence Interval (y): 0.429 +/- 0.042
Confidence Interval Corrected Mfg. (y): 0.429 +/- 0.042
UCL: 0.471
UCL Mfg. Corrected: 0.471
LCL: 0.387
LCL Mfg. Corrected: 0.387
Prediction Interval (y): 0.429 +/- 0.133
One-sample Mfg. t-test: t-statistic Mfg.=12.118, p-value=1.99018598487458e-06
             Reject Mfg. Ho (ymean = u): True
################################################
```

```
########## Target 2.0 ppm Statistics ##########
n: 9
Min (y): 2.15
Max (y): 2.38
Mean (y): 2.264
Mean Corrected Mfg. (y): 2.264
Median (y): 2.25
Sample Standard Deviation (y): 0.07
Variance (y): 0.005
Mean Percent Error Mfg. (y): 13.222
% Relative Standard Deviation (y): 3.074
MSE: 0.075
Alpha: 0.05
df: (n - 2) = 7
t-value: 2.365
Confidence Interval (y): 2.264 +/- 0.055
Confidence Interval Corrected Mfg. (y): 2.264 +/- 0.055
UCL: 2.319
UCL Mfg. Corrected: 2.319
LCL: 2.209
LCL Mfg. Corrected: 2.209
Prediction Interval (y): 2.264 +/- 0.174
One-sample Mfg. t-test: t-statistic Mfg.=10.744, p-value=4.956914968981681e-06
             Reject Mfg. Ho (ymean = u): True
################################################

########## Target 9.699 ppm Statistics ##########
n: 9
Min (y): 9.95
Max (y): 10.38
Mean (y): 10.114
Mean Corrected Mfg. (y): 10.114
Median (y): 10.06
Sample Standard Deviation (y): 0.146
Variance (y): 0.021
Mean Percent Error Mfg. (y): 4.283
% Relative Standard Deviation (y): 1.448
MSE: 0.194
Alpha: 0.05
df: (n - 2) = 7
t-value: 2.365
Confidence Interval (y): 10.114 +/- 0.115
Confidence Interval Corrected Mfg. (y): 10.114 +/- 0.115
UCL: 10.229
UCL Mfg. Corrected: 10.229
LCL: 9.999
LCL Mfg. Corrected: 9.999
Prediction Interval (y): 10.114 +/- 0.365
One-sample Mfg. t-test: t-statistic Mfg.=8.024, p-value=4.274734980136545e-05
             Reject Mfg. Ho (ymean = u): True
################################################
```

========== Butyl Acrylate Calibrated MultiRAE Pro (ER) Statistics ==========

Date: 2023-05-05
Start: 11:04:30
Stop: 13:03:40

NOTE: VALUES WHICH HAVE THE ABREVIATION "MFG." HAVE THE MANUFACTURER
CORRECTION FACTOR APPLIED TO THE VALUE.

########## Regression Statistics ##########
n: 60
Mean Percent Error (Mfg.): -20.776
Mean Percent Error (Assessment): -16.467
% Relative Standard Deviation (x): 186.278
% Relative Standard Deviation (y): 185.16
Standard Deviation (x): 3.381
Standard Deviation (y): 3.53
Variance (x): 11.429
Variance (y): 12.464
Covariance (xy): 12.129
Alpha: 0.05
df: (n - 2) = 58
t-value: 2.002
Correlation Coefficient (R): 0.999
R^2: 0.999
MSE (yh): 0.018
Slope: 1.044
Slope Standard Error: 0.005
Slope p-value: 3.6385948019514817e-84 (Ho: slope = 0)
y-Intercept: 0.013
y-Intercept Standard Error: 0.02
Regression Equation: y = 1.044(x) + 0.013
Confidence Interval (Slope): 1.044 +/- 0.01
UCL (Slope): 1.054
LCL (Slope): 1.034
Honeywell Correction Factor: 1.0
Isobutylene Calibration Slope: 0.997
Assessment Correction Factor: 0.955
##

```
########## Target 0.0 ppm Statistics ##########
n: 24
Min (y): 0.0
Max (y): 0.3
Mean (y): 0.096
Mean Corrected Mfg. (y): 0.096
Median (y): 0.0
Sample Standard Deviation (y): 0.11
Variance (y): 0.012
Mean Percent Error Mfg. (y): nan
% Relative Standard Deviation (y): 114.621
MSE: 0.021
Alpha: 0.05
df: (n - 2) = 22
t-value: 2.074
Confidence Interval (y): 0.096 +/- 0.047
Confidence Interval Corrected Mfg. (y): 0.096 +/- 0.047
UCL: 0.143
UCL Mfg. Corrected: 0.143
LCL: 0.049
LCL Mfg. Corrected: 0.049
Prediction Interval (y): 0.096 +/- 0.233
One-sample Mfg. t-test: t-statistic Mfg.=4.184, p-value=0.0003558773352554333
             Reject Mfg. Ho (ymean = u): True
################################################

########## Target 0.2 ppm Statistics ##########
n: 18
Min (y): 0.0
Max (y): 0.3
Mean (y): 0.144
Mean Corrected Mfg. (y): 0.144
Median (y): 0.1
Sample Standard Deviation (y): 0.076
Variance (y): 0.006
Mean Percent Error Mfg. (y): -27.778
% Relative Standard Deviation (y): 52.736
MSE: 0.009
Alpha: 0.05
df: (n - 2) = 16
t-value: 2.12
Confidence Interval (y): 0.144 +/- 0.038
Confidence Interval Corrected Mfg. (y): 0.144 +/- 0.038
UCL: 0.182
UCL Mfg. Corrected: 0.182
LCL: 0.106
LCL Mfg. Corrected: 0.106
Prediction Interval (y): 0.144 +/- 0.166
One-sample Mfg. t-test: t-statistic Mfg.=-3.007, p-value=0.007933939339956862
             Reject Mfg. Ho (ymean = u): True
################################################
```

```
########## Target 2.0 ppm Statistics ##########
n: 9
Min (y): 2.0
Max (y): 2.1
Mean (y): 2.011
Mean Corrected Mfg. (y): 2.011
Median (y): 2.0
Sample Standard Deviation (y): 0.031
Variance (y): 0.001
Mean Percent Error Mfg. (y): 0.556
% Relative Standard Deviation (y): 1.563
MSE: 0.001
Alpha: 0.05
df: (n - 2) = 7
t-value: 2.365
Confidence Interval (y): 2.011 +/- 0.025
Confidence Interval Corrected Mfg. (y): 2.011 +/- 0.025
UCL: 2.036
UCL Mfg. Corrected: 2.036
LCL: 1.986
LCL Mfg. Corrected: 1.986
Prediction Interval (y): 2.011 +/- 0.078
One-sample Mfg. t-test: t-statistic Mfg.=1.0, p-value=0.3465935070873362
             Reject Mfg. Ho (ymean = u): False
################################################

########## Target 9.699 ppm Statistics ##########
n: 9
Min (y): 9.9
Max (y): 10.4
Mean (y): 10.156
Mean Corrected Mfg. (y): 10.156
Median (y): 10.2
Sample Standard Deviation (y): 0.189
Variance (y): 0.036
Mean Percent Error Mfg. (y): 4.707
% Relative Standard Deviation (y): 1.863
MSE: 0.244
Alpha: 0.05
df: (n - 2) = 7
t-value: 2.365
Confidence Interval (y): 10.156 +/- 0.149
Confidence Interval Corrected Mfg. (y): 10.156 +/- 0.149
UCL: 10.305
UCL Mfg. Corrected: 10.305
LCL: 10.007
LCL Mfg. Corrected: 10.007
Prediction Interval (y): 10.156 +/- 0.472
One-sample Mfg. t-test: t-statistic Mfg.=6.825, p-value=0.0001344022657217045
             Reject Mfg. Ho (ymean = u): True
################################################
```

========== Butyl Acrylate Calibrated MultiRAE Pro (PPB) Statistics ==========

Date: 2023-05-02
Start: 16:06:00
Stop: 17:34:23

NOTE: VALUES WHICH HAVE THE ABREVIATION "MFG." HAVE THE MANUFACTURER
CORRECTION FACTOR APPLIED TO THE VALUE.

########## Regression Statistics ##########
n: 57
Mean Percent Error (Mfg.): 23.606
Mean Percent Error (Assessment): 83.291
% Relative Standard Deviation (x): 182.65
% Relative Standard Deviation (y): 178.455
Standard Deviation (x): 3.452
Standard Deviation (y): 3.59
Variance (x): 11.919
Variance (y): 12.891
Covariance (xy): 12.611
Alpha: 0.05
df: (n - 2) = 55
t-value: 2.004
Correlation Coefficient (R): 1.0
R^2: 0.999
MSE (yh): 0.011
Slope: 1.04
Slope Standard Error: 0.004
Slope p-value: 5.035237252844899e-86 (Ho: slope = 0)
y-Intercept: 0.047
y-Intercept Standard Error: 0.016
Regression Equation: y = 1.04(x) + 0.047
Confidence Interval (Slope): 1.04 +/- 0.008
UCL (Slope): 1.048
LCL (Slope): 1.032
Honeywell Correction Factor: 1.0
Isobutylene Calibration Slope: 0.963
Assessment Correction Factor: 0.926
##

```
########## Target 0.0 ppm Statistics ##########
n: 12
Min (y): 0.04
Max (y): 0.22
Mean (y): 0.112
Mean Corrected Mfg. (y): 0.112
Median (y): 0.085
Sample Standard Deviation (y): 0.064
Variance (y): 0.004
Mean Percent Error Mfg. (y): nan
% Relative Standard Deviation (y): 57.671
MSE: 0.017
Alpha: 0.05
df: (n - 2) = 10
t-value: 2.228
Confidence Interval (y): 0.112 +/- 0.041
Confidence Interval Corrected Mfg. (y): 0.112 +/- 0.041
UCL: 0.153
UCL Mfg. Corrected: 0.153
LCL: 0.071
LCL Mfg. Corrected: 0.071
Prediction Interval (y): 0.112 +/- 0.149
One-sample Mfg. t-test: t-statistic Mfg.=5.751, p-value=0.00012818733185872018
             Reject Mfg. Ho (ymean = u): True
################################################

########## Target 0.022 ppm Statistics ##########
n: 9
Min (y): 0.01
Max (y): 0.2
Mean (y): 0.098
Mean Corrected Mfg. (y): 0.098
Median (y): 0.09
Sample Standard Deviation (y): 0.067
Variance (y): 0.004
Mean Percent Error Mfg. (y): 344.444
% Relative Standard Deviation (y): 68.314
MSE: 0.01
Alpha: 0.05
df: (n - 2) = 7
t-value: 2.365
Confidence Interval (y): 0.098 +/- 0.053
Confidence Interval Corrected Mfg. (y): 0.098 +/- 0.053
UCL: 0.151
UCL Mfg. Corrected: 0.151
LCL: 0.045
LCL Mfg. Corrected: 0.045
Prediction Interval (y): 0.098 +/- 0.166
One-sample Mfg. t-test: t-statistic Mfg.=3.209, p-value=0.012447725130964739
             Reject Mfg. Ho (ymean = u): True
################################################
```

```
########## Target 0.05 ppm Statistics ##########
n: 9
Min (y): 0.03
Max (y): 0.22
Mean (y): 0.13
Mean Corrected Mfg. (y): 0.13
Median (y): 0.14
Sample Standard Deviation (y): 0.068
Variance (y): 0.005
Mean Percent Error Mfg. (y): 160.0
% Relative Standard Deviation (y): 52.548
MSE: 0.011
Alpha: 0.05
df: (n - 2) = 7
t-value: 2.365
Confidence Interval (y): 0.13 +/- 0.054
Confidence Interval Corrected Mfg. (y): 0.13 +/- 0.054
UCL: 0.184
UCL Mfg. Corrected: 0.184
LCL: 0.076
LCL Mfg. Corrected: 0.076
Prediction Interval (y): 0.13 +/- 0.17
One-sample Mfg. t-test: t-statistic Mfg.=3.312, p-value=0.010661386349127406
             Reject Mfg. Ho (ymean = u): True
################################################

########## Target 0.2 ppm Statistics ##########
n: 9
Min (y): 0.09
Max (y): 0.25
Mean (y): 0.154
Mean Corrected Mfg. (y): 0.154
Median (y): 0.13
Sample Standard Deviation (y): 0.06
Variance (y): 0.004
Mean Percent Error Mfg. (y): -22.778
% Relative Standard Deviation (y): 38.622
MSE: 0.006
Alpha: 0.05
df: (n - 2) = 7
t-value: 2.365
Confidence Interval (y): 0.154 +/- 0.047
Confidence Interval Corrected Mfg. (y): 0.154 +/- 0.047
UCL: 0.201
UCL Mfg. Corrected: 0.201
LCL: 0.107
LCL Mfg. Corrected: 0.107
Prediction Interval (y): 0.154 +/- 0.149
One-sample Mfg. t-test: t-statistic Mfg.=-2.16, p-value=0.06277571885031956
             Reject Mfg. Ho (ymean = u): False
################################################
```

```
########## Target 2.0 ppm Statistics ##########
n: 9
Min (y): 2.02
Max (y): 2.13
Mean (y): 2.068
Mean Corrected Mfg. (y): 2.068
Median (y): 2.04
Sample Standard Deviation (y): 0.048
Variance (y): 0.002
Mean Percent Error Mfg. (y): 3.389
% Relative Standard Deviation (y): 2.3
MSE: 0.007
Alpha: 0.05
df: (n - 2) = 7
t-value: 2.365
Confidence Interval (y): 2.068 +/- 0.037
Confidence Interval Corrected Mfg. (y): 2.068 +/- 0.037
UCL: 2.105
UCL Mfg. Corrected: 2.105
LCL: 2.031
LCL Mfg. Corrected: 2.031
Prediction Interval (y): 2.068 +/- 0.119
One-sample Mfg. t-test: t-statistic Mfg.=4.031, p-value=0.003782825261958395
             Reject Mfg. Ho (ymean = u): True
################################################

########## Target 9.699 ppm Statistics ##########
n: 9
Min (y): 9.88
Max (y): 10.35
Mean (y): 10.143
Mean Corrected Mfg. (y): 10.143
Median (y): 10.14
Sample Standard Deviation (y): 0.169
Variance (y): 0.029
Mean Percent Error Mfg. (y): 4.581
% Relative Standard Deviation (y): 1.667
MSE: 0.226
Alpha: 0.05
df: (n - 2) = 7
t-value: 2.365
Confidence Interval (y): 10.143 +/- 0.133
Confidence Interval Corrected Mfg. (y): 10.143 +/- 0.133
UCL: 10.276
UCL Mfg. Corrected: 10.276
LCL: 10.01
LCL Mfg. Corrected: 10.01
Prediction Interval (y): 10.143 +/- 0.421
One-sample Mfg. t-test: t-statistic Mfg.=7.434, p-value=7.374019030852044e-05
             Reject Mfg. Ho (ymean = u): True
################################################
```

========== Butyl Acrylate Calibrated ppbRAE 3000 Statistics ==========

Date: 2023-05-03
Start: 14:27:11
Stop: 16:05:27

NOTE: VALUES WHICH HAVE THE ABREVIATION "MFG." HAVE THE MANUFACTURER CORRECTION FACTOR APPLIED TO THE VALUE.

########## Regression Statistics ##########
n: 57
Mean Percent Error (Mfg.): -128.414
Mean Percent Error (Assessment): -33.828
% Relative Standard Deviation (x): 182.65
% Relative Standard Deviation (y): 185.468
Standard Deviation (x): 3.452
Standard Deviation (y): 3.635
Variance (x): 11.919
Variance (y): 13.212
Covariance (xy): 12.768
Alpha: 0.05
df: (n - 2) = 55
t-value: 2.004
Correlation Coefficient (R): 1.0
R^2: 0.999
MSE (yh): 0.011
Slope: 1.052
Slope Standard Error: 0.004
Slope p-value: 1.836217170341827e-86 (Ho: slope = 0)
y-Intercept: -0.029
y-Intercept Standard Error: 0.016
Regression Equation: y = 1.052(x) - 0.029
Confidence Interval (Slope): 1.052 +/- 0.008
UCL (Slope): 1.06
LCL (Slope): 1.044
Honeywell Correction Factor: 1.0
Isobutylene Calibration Slope: 0.883
Assessment Correction Factor: 0.839
##

```
########## Target 0.0 ppm Statistics ##########
n: 12
Min (y): 0.0
Max (y): 0.0
Mean (y): 0.0
Mean Corrected Mfg. (y): 0.0
Median (y): 0.0
Sample Standard Deviation (y): 0.0
Variance (y): 0.0
Mean Percent Error Mfg. (y): nan
% Relative Standard Deviation (y): None
MSE: 0.0
Alpha: 0.05
df: (n - 2) = 10
t-value: 2.228
Confidence Interval (y): 0.0 +/- 0.0
Confidence Interval Corrected Mfg. (y): 0.0 +/- 0.0
UCL: 0.0
UCL Mfg. Corrected: 0.0
LCL: 0.0
LCL Mfg. Corrected: 0.0
Prediction Interval (y): 0.0 +/- 0.0
One-sample Mfg. t-test: t-statistic Mfg.=nan, p-value=nan
              Reject Mfg. Ho (ymean = u): False
################################################

########## Target 0.022 ppm Statistics ##########
n: 9
Min (y): 0.0
Max (y): 0.011
Mean (y): 0.003
Mean Corrected Mfg. (y): 0.003
Median (y): 0.0
Sample Standard Deviation (y): 0.004
Variance (y): 0.0
Mean Percent Error Mfg. (y): -88.384
% Relative Standard Deviation (y): 141.822
MSE: 0.0
Alpha: 0.05
df: (n - 2) = 7
t-value: 2.365
Confidence Interval (y): 0.003 +/- 0.003
Confidence Interval Corrected Mfg. (y): 0.003 +/- 0.003
UCL: 0.006
UCL Mfg. Corrected: 0.006
LCL: 0.0
LCL Mfg. Corrected: 0.0
Prediction Interval (y): 0.003 +/- 0.009
One-sample Mfg. t-test: t-statistic Mfg.=-15.174, p-value=3.5229636898845786e-07
              Reject Mfg. Ho (ymean = u): True
################################################
```

```
########## Target 0.05 ppm Statistics ##########
n: 9
Min (y): 0.0
Max (y): 0.074
Mean (y): 0.033
Mean Corrected Mfg. (y): 0.033
Median (y): 0.036
Sample Standard Deviation (y): 0.031
Variance (y): 0.001
Mean Percent Error Mfg. (y): -33.111
% Relative Standard Deviation (y): 93.36
MSE: 0.001
Alpha: 0.05
df: (n - 2) = 7
t-value: 2.365
Confidence Interval (y): 0.033 +/- 0.025
Confidence Interval Corrected Mfg. (y): 0.033 +/- 0.025
UCL: 0.058
UCL Mfg. Corrected: 0.058
LCL: 0.008
LCL Mfg. Corrected: 0.008
Prediction Interval (y): 0.033 +/- 0.078
One-sample Mfg. t-test: t-statistic Mfg.=-1.5, p-value=0.172078230203706
             Reject Mfg. Ho (ymean = u): False
################################################

########## Target 0.2 ppm Statistics ##########
n: 9
Min (y): 0.158
Max (y): 0.285
Mean (y): 0.227
Mean Corrected Mfg. (y): 0.227
Median (y): 0.204
Sample Standard Deviation (y): 0.045
Variance (y): 0.002
Mean Percent Error Mfg. (y): 13.5
% Relative Standard Deviation (y): 20.001
MSE: 0.003
Alpha: 0.05
df: (n - 2) = 7
t-value: 2.365
Confidence Interval (y): 0.227 +/- 0.036
Confidence Interval Corrected Mfg. (y): 0.227 +/- 0.036
UCL: 0.263
UCL Mfg. Corrected: 0.263
LCL: 0.191
LCL Mfg. Corrected: 0.191
Prediction Interval (y): 0.227 +/- 0.113
One-sample Mfg. t-test: t-statistic Mfg.=1.682, p-value=0.1310654748796876
             Reject Mfg. Ho (ymean = u): False
################################################
```

```
########## Target 2.0 ppm Statistics ##########
n: 9
Min (y): 1.876
Max (y): 2.026
Mean (y): 1.945
Mean Corrected Mfg. (y): 1.945
Median (y): 1.924
Sample Standard Deviation (y): 0.05
Variance (y): 0.003
Mean Percent Error Mfg. (y): -2.728
% Relative Standard Deviation (y): 2.589
MSE: 0.006
Alpha: 0.05
df: (n - 2) = 7
t-value: 2.365
Confidence Interval (y): 1.945 +/- 0.04
Confidence Interval Corrected Mfg. (y): 1.945 +/- 0.04
UCL: 1.985
UCL Mfg. Corrected: 1.985
LCL: 1.905
LCL Mfg. Corrected: 1.905
Prediction Interval (y): 1.945 +/- 0.126
One-sample Mfg. t-test: t-statistic Mfg.=-3.064, p-value=0.015497833850580614
             Reject Mfg. Ho (ymean = u): True
################################################

########## Target 9.699 ppm Statistics ##########
n: 9
Min (y): 9.894
Max (y): 10.39
Mean (y): 10.204
Mean Corrected Mfg. (y): 10.204
Median (y): 10.32
Sample Standard Deviation (y): 0.206
Variance (y): 0.043
Mean Percent Error Mfg. (y): 5.204
% Relative Standard Deviation (y): 2.023
MSE: 0.297
Alpha: 0.05
df: (n - 2) = 7
t-value: 2.365
Confidence Interval (y): 10.204 +/- 0.163
Confidence Interval Corrected Mfg. (y): 10.204 +/- 0.163
UCL: 10.367
UCL Mfg. Corrected: 10.367
LCL: 10.041
LCL Mfg. Corrected: 10.041
Prediction Interval (y): 10.204 +/- 0.515
One-sample Mfg. t-test: t-statistic Mfg.=6.915, p-value=0.00012261249987017525
             Reject Mfg. Ho (ymean = u): True
################################################
```

========== Butyl Acrylate MultiRAE Pro (ER) Statistics ==========

Date: 2023-05-05
Start: 09:35:30
Stop: 10:52:42

NOTE: VALUES WHICH HAVE THE ABREVIATION "MFG." HAVE THE MANUFACTURER CORRECTION FACTOR APPLIED TO THE VALUE.

########## Regression Statistics ##########
n: 42
Mean Percent Error (Mfg.): -19.288
Mean Percent Error (Assessment): -16.325
% Relative Standard Deviation (x): 149.456
% Relative Standard Deviation (y): 154.43
Standard Deviation (x): 3.811
Standard Deviation (y): 1.919
Variance (x): 14.522
Variance (y): 3.684
Covariance (xy): 7.469
Alpha: 0.05
df: (n - 2) = 40
t-value: 2.021
Correlation Coefficient (R): 0.997
R^2: 0.994
MSE (yh): 0.023
Slope: 0.502
Slope Standard Error: 0.006
Slope p-value: 1.278622260086416e-45 (Ho: slope = 0)
y-Intercept: -0.037
y-Intercept Standard Error: 0.029
Regression Equation: y = 0.502(x) - 0.037
Confidence Interval (Slope): 0.502 +/- 0.013
UCL (Slope): 0.515
LCL (Slope): 0.489
Honeywell Correction Factor: 1.6
Isobutylene Calibration Slope: 0.997
Assessment Correction Factor: 1.986
##

```
########## Target 0.0 ppm Statistics ##########
n: 15
Min (y): 0.0
Max (y): 0.1
Mean (y): 0.06
Mean Corrected Mfg. (y): 0.096
Median (y): 0.1
Sample Standard Deviation (y): 0.049
Variance (y): 0.002
Mean Percent Error Mfg. (y): nan
% Relative Standard Deviation (y): 81.65
MSE: 0.015
Alpha: 0.05
df: (n - 2) = 13
t-value: 2.16
Confidence Interval (y): 0.06 +/- 0.027
Confidence Interval Corrected Mfg. (y): 0.096 +/- 0.044
UCL: 0.087
UCL Mfg. Corrected: 0.14
LCL: 0.033
LCL Mfg. Corrected: 0.052
Prediction Interval (y): 0.06 +/- 0.109
One-sample Mfg. t-test: t-statistic Mfg.=4.583, p-value=0.00042637575734322437
             Reject Mfg. Ho (ymean = u): True
################################################

########## Target 0.2 ppm Statistics ##########
n: 9
Min (y): 0.0
Max (y): 0.1
Mean (y): 0.078
Mean Corrected Mfg. (y): 0.124
Median (y): 0.1
Sample Standard Deviation (y): 0.042
Variance (y): 0.002
Mean Percent Error Mfg. (y): -37.778
% Relative Standard Deviation (y): 53.452
MSE: 0.01
Alpha: 0.05
df: (n - 2) = 7
t-value: 2.365
Confidence Interval (y): 0.078 +/- 0.033
Confidence Interval Corrected Mfg. (y): 0.124 +/- 0.052
UCL: 0.111
UCL Mfg. Corrected: 0.176
LCL: 0.045
LCL Mfg. Corrected: 0.072
Prediction Interval (y): 0.078 +/- 0.104
One-sample Mfg. t-test: t-statistic Mfg.=-3.213, p-value=0.012374070003721462
             Reject Mfg. Ho (ymean = u): True
################################################
```

```
########## Target 2.0 ppm Statistics ##########
n: 9
Min (y): 0.7
Max (y): 0.8
Mean (y): 0.744
Mean Corrected Mfg. (y): 1.191
Median (y): 0.7
Sample Standard Deviation (y): 0.05
Variance (y): 0.002
Mean Percent Error Mfg. (y): -40.444
% Relative Standard Deviation (y): 6.675
MSE: 0.661
Alpha: 0.05
df: (n - 2) = 7
t-value: 2.365
Confidence Interval (y): 0.744 +/- 0.039
Confidence Interval Corrected Mfg. (y): 1.191 +/- 0.063
UCL: 0.783
UCL Mfg. Corrected: 1.254
LCL: 0.705
LCL Mfg. Corrected: 1.128
Prediction Interval (y): 0.744 +/- 0.124
One-sample Mfg. t-test: t-statistic Mfg.=-28.777, p-value=2.300668778130005e-09
             Reject Mfg. Ho (ymean = u): True
################################################

########## Target 9.699 ppm Statistics ##########
n: 9
Min (y): 4.6
Max (y): 5.1
Mean (y): 4.878
Mean Corrected Mfg. (y): 7.804
Median (y): 5.0
Sample Standard Deviation (y): 0.181
Variance (y): 0.033
Mean Percent Error Mfg. (y): -19.534
% Relative Standard Deviation (y): 3.715
MSE: 3.673
Alpha: 0.05
df: (n - 2) = 7
t-value: 2.365
Confidence Interval (y): 4.878 +/- 0.143
Confidence Interval Corrected Mfg. (y): 7.804 +/- 0.229
UCL: 5.021
UCL Mfg. Corrected: 8.033
LCL: 4.735
LCL Mfg. Corrected: 7.575
Prediction Interval (y): 4.878 +/- 0.452
One-sample Mfg. t-test: t-statistic Mfg.=-18.481, p-value=7.570799106181063e-08
             Reject Mfg. Ho (ymean = u): True
################################################
```

========== Butyl Acrylate MultiRAE Pro (PPB) Statistics ==========

Date: 2023-05-02
Start: 13:16:21
Stop: 15:40:02

NOTE: VALUES WHICH HAVE THE ABREVIATION "MFG." HAVE THE MANUFACTURER CORRECTION FACTOR APPLIED TO THE VALUE.

########## Regression Statistics ##########
n: 78
Mean Percent Error (Mfg.): -90.486
Mean Percent Error (Assessment): -26.541
% Relative Standard Deviation (x): 185.748
% Relative Standard Deviation (y): 199.529
Standard Deviation (x): 3.421
Standard Deviation (y): 1.766
Variance (x): 11.703
Variance (y): 3.12
Covariance (xy): 6.102
Alpha: 0.05
df: (n - 2) = 76
t-value: 1.992
Correlation Coefficient (R): 0.997
R^2: 0.994
MSE (yh): 0.019
Slope: 0.515
Slope Standard Error: 0.005
Slope p-value: 1.0215527068255553e-85 (Ho: slope = 0)
y-Intercept: -0.063
y-Intercept Standard Error: 0.018
Regression Equation: y = 0.515(x) - 0.063
Confidence Interval (Slope): 0.515 +/- 0.009
UCL (Slope): 0.524
LCL (Slope): 0.506
Honeywell Correction Factor: 1.6
Isobutylene Calibration Slope: 0.963
Assessment Correction Factor: 1.87
##

```
########## Target 0.0 ppm Statistics ##########
n: 18
Min (y): 0.0
Max (y): 0.08
Mean (y): 0.016
Mean Corrected Mfg. (y): 0.025
Median (y): 0.0
Sample Standard Deviation (y): 0.021
Variance (y): 0.0
Mean Percent Error Mfg. (y): nan
% Relative Standard Deviation (y): 137.581
MSE: 0.002
Alpha: 0.05
df: (n - 2) = 16
t-value: 2.12
Confidence Interval (y): 0.016 +/- 0.011
Confidence Interval Corrected Mfg. (y): 0.025 +/- 0.017
UCL: 0.027
UCL Mfg. Corrected: 0.042
LCL: 0.005
LCL Mfg. Corrected: 0.008
Prediction Interval (y): 0.016 +/- 0.047
One-sample Mfg. t-test: t-statistic Mfg.=2.997, p-value=0.008108904072287234
             Reject Mfg. Ho (ymean = u): True
################################################

########## Target 0.022 ppm Statistics ##########
n: 12
Min (y): 0.0
Max (y): 0.07
Mean (y): 0.015
Mean Corrected Mfg. (y): 0.024
Median (y): 0.005
Sample Standard Deviation (y): 0.021
Variance (y): 0.0
Mean Percent Error Mfg. (y): 9.091
% Relative Standard Deviation (y): 137.437
MSE: 0.001
Alpha: 0.05
df: (n - 2) = 10
t-value: 2.228
Confidence Interval (y): 0.015 +/- 0.013
Confidence Interval Corrected Mfg. (y): 0.024 +/- 0.021
UCL: 0.028
UCL Mfg. Corrected: 0.045
LCL: 0.002
LCL Mfg. Corrected: 0.003
Prediction Interval (y): 0.015 +/- 0.048
One-sample Mfg. t-test: t-statistic Mfg.=0.201, p-value=0.8442906791298765
             Reject Mfg. Ho (ymean = u): False
################################################
```

```
########## Target 0.05 ppm Statistics ##########
n: 12
Min (y): 0.0
Max (y): 0.07
Mean (y): 0.014
Mean Corrected Mfg. (y): 0.023
Median (y): 0.01
Sample Standard Deviation (y): 0.019
Variance (y): 0.0
Mean Percent Error Mfg. (y): -54.667
% Relative Standard Deviation (y): 133.492
MSE: 0.002
Alpha: 0.05
df: (n - 2) = 10
t-value: 2.228
Confidence Interval (y): 0.014 +/- 0.012
Confidence Interval Corrected Mfg. (y): 0.023 +/- 0.019
UCL: 0.026
UCL Mfg. Corrected: 0.042
LCL: 0.002
LCL Mfg. Corrected: 0.004
Prediction Interval (y): 0.014 +/- 0.044
One-sample Mfg. t-test: t-statistic Mfg.=-2.996, p-value=0.01216579535475874
             Reject Mfg. Ho (ymean = u): True
################################################

########## Target 0.2 ppm Statistics ##########
n: 12
Min (y): 0.0
Max (y): 0.06
Mean (y): 0.028
Mean Corrected Mfg. (y): 0.045
Median (y): 0.03
Sample Standard Deviation (y): 0.017
Variance (y): 0.0
Mean Percent Error Mfg. (y): -77.333
% Relative Standard Deviation (y): 59.117
MSE: 0.025
Alpha: 0.05
df: (n - 2) = 10
t-value: 2.228
Confidence Interval (y): 0.028 +/- 0.011
Confidence Interval Corrected Mfg. (y): 0.045 +/- 0.017
UCL: 0.039
UCL Mfg. Corrected: 0.062
LCL: 0.017
LCL Mfg. Corrected: 0.028
Prediction Interval (y): 0.028 +/- 0.039
One-sample Mfg. t-test: t-statistic Mfg.=-19.141, p-value=8.554842782646125e-10
             Reject Mfg. Ho (ymean = u): True
################################################
```

```
########## Target 2.0 ppm Statistics ##########
n: 12
Min (y): 0.62
Max (y): 0.79
Mean (y): 0.686
Mean Corrected Mfg. (y): 1.097
Median (y): 0.665
Sample Standard Deviation (y): 0.055
Variance (y): 0.003
Mean Percent Error Mfg. (y): -45.133
% Relative Standard Deviation (y): 8.085
MSE: 0.823
Alpha: 0.05
df: (n - 2) = 10
t-value: 2.228
Confidence Interval (y): 0.686 +/- 0.036
Confidence Interval Corrected Mfg. (y): 1.097 +/- 0.057
UCL: 0.722
UCL Mfg. Corrected: 1.154
LCL: 0.65
LCL Mfg. Corrected: 1.04
Prediction Interval (y): 0.686 +/- 0.129
One-sample Mfg. t-test: t-statistic Mfg.=-33.747, p-value=1.850623552300888e-12
             Reject Mfg. Ho (ymean = u): True
################################################

########## Target 9.699 ppm Statistics ##########
n: 12
Min (y): 4.57
Max (y): 5.17
Mean (y): 4.988
Mean Corrected Mfg. (y): 7.98
Median (y): 5.0
Sample Standard Deviation (y): 0.148
Variance (y): 0.022
Mean Percent Error Mfg. (y): -17.723
% Relative Standard Deviation (y): 2.962
MSE: 3.011
Alpha: 0.05
df: (n - 2) = 10
t-value: 2.228
Confidence Interval (y): 4.988 +/- 0.095
Confidence Interval Corrected Mfg. (y): 7.98 +/- 0.152
UCL: 5.083
UCL Mfg. Corrected: 8.132
LCL: 4.893
LCL Mfg. Corrected: 7.828
Prediction Interval (y): 4.988 +/- 0.343
One-sample Mfg. t-test: t-statistic Mfg.=-24.123, p-value=7.094857731634004e-11
             Reject Mfg. Ho (ymean = u): True
################################################
```

========== Butyl Acrylate ppbRAE 3000 Statistics ==========

Date: 2023-05-06
Start: 13:13:46
Stop: 15:49:19

NOTE: VALUES WHICH HAVE THE ABREVIATION "MFG." HAVE THE MANUFACTURER CORRECTION FACTOR APPLIED TO THE VALUE.

########## Regression Statistics ##########
n: 102
Mean Percent Error (Mfg.): 66.105
Mean Percent Error (Assessment): 143.992
% Relative Standard Deviation (x): 253.761
% Relative Standard Deviation (y): 232.231
Standard Deviation (x): 2.738
Standard Deviation (y): 1.301
Variance (x): 7.497
Variance (y): 1.693
Covariance (xy): 3.595
Alpha: 0.05
df: (n - 2) = 100
t-value: 1.984
Correlation Coefficient (R): 0.999
R^2: 0.999
MSE (yh): 0.002
Slope: 0.475
Slope Standard Error: 0.002
Slope p-value: 1.3416895963073647e-148 (Ho: slope = 0)
y-Intercept: 0.048
y-Intercept Standard Error: 0.005
Regression Equation: y = 0.475(x) + 0.048
Confidence Interval (Slope): 0.475 +/- 0.003
UCL (Slope): 0.478
LCL (Slope): 0.472
Honeywell Correction Factor: 1.6
Isobutylene Calibration Slope: 0.883
Assessment Correction Factor: 1.859
##

```
########## Target 0.0 ppm Statistics ##########
n: 36
Min (y): 0.0
Max (y): 0.137
Mean (y): 0.034
Mean Corrected Mfg. (y): 0.055
Median (y): 0.013
Sample Standard Deviation (y): 0.043
Variance (y): 0.002
Mean Percent Error Mfg. (y): nan
% Relative Standard Deviation (y): 124.951
MSE: 0.008
Alpha: 0.05
df: (n - 2) = 34
t-value: 2.032
Confidence Interval (y): 0.034 +/- 0.015
Confidence Interval Corrected Mfg. (y): 0.055 +/- 0.023
UCL: 0.049
UCL Mfg. Corrected: 0.078
LCL: 0.019
LCL Mfg. Corrected: 0.032
Prediction Interval (y): 0.034 +/- 0.089
One-sample Mfg. t-test: t-statistic Mfg.=4.735, p-value=3.565973339527615e-05
             Reject Mfg. Ho (ymean = u): True
################################################

########## Target 0.022 ppm Statistics ##########
n: 12
Min (y): 0.0
Max (y): 0.133
Mean (y): 0.062
Mean Corrected Mfg. (y): 0.1
Median (y): 0.06
Sample Standard Deviation (y): 0.045
Variance (y): 0.002
Mean Percent Error Mfg. (y): 353.939
% Relative Standard Deviation (y): 72.479
MSE: 0.011
Alpha: 0.05
df: (n - 2) = 10
t-value: 2.228
Confidence Interval (y): 0.062 +/- 0.029
Confidence Interval Corrected Mfg. (y): 0.1 +/- 0.047
UCL: 0.091
UCL Mfg. Corrected: 0.147
LCL: 0.033
LCL Mfg. Corrected: 0.053
Prediction Interval (y): 0.062 +/- 0.105
One-sample Mfg. t-test: t-statistic Mfg.=3.568, p-value=0.004411199974035564
             Reject Mfg. Ho (ymean = u): True
################################################
```

```
########## Target 0.05 ppm Statistics ##########
n: 18
Min (y): 0.036
Max (y): 0.157
Mean (y): 0.078
Mean Corrected Mfg. (y): 0.126
Median (y): 0.072
Sample Standard Deviation (y): 0.036
Variance (y): 0.001
Mean Percent Error Mfg. (y): 151.2
% Relative Standard Deviation (y): 45.754
MSE: 0.009
Alpha: 0.05
df: (n - 2) = 16
t-value: 2.12
Confidence Interval (y): 0.078 +/- 0.018
Confidence Interval Corrected Mfg. (y): 0.126 +/- 0.029
UCL: 0.096
UCL Mfg. Corrected: 0.155
LCL: 0.06
LCL Mfg. Corrected: 0.097
Prediction Interval (y): 0.078 +/- 0.078
One-sample Mfg. t-test: t-statistic Mfg.=5.424, p-value=4.557370549906981e-05
             Reject Mfg. Ho (ymean = u): True
################################################

########## Target 0.2 ppm Statistics ##########
n: 18
Min (y): 0.115
Max (y): 0.256
Mean (y): 0.174
Mean Corrected Mfg. (y): 0.279
Median (y): 0.168
Sample Standard Deviation (y): 0.04
Variance (y): 0.002
Mean Percent Error Mfg. (y): 39.333
% Relative Standard Deviation (y): 22.97
MSE: 0.01
Alpha: 0.05
df: (n - 2) = 16
t-value: 2.12
Confidence Interval (y): 0.174 +/- 0.02
Confidence Interval Corrected Mfg. (y): 0.279 +/- 0.032
UCL: 0.194
UCL Mfg. Corrected: 0.311
LCL: 0.154
LCL Mfg. Corrected: 0.247
Prediction Interval (y): 0.174 +/- 0.087
One-sample Mfg. t-test: t-statistic Mfg.=5.067, p-value=9.522094313889009e-05
             Reject Mfg. Ho (ymean = u): True
################################################
```

```
########## Target 2.0 ppm Statistics ##########
n: 9
Min (y): 0.91
Max (y): 1.03
Mean (y): 0.964
Mean Corrected Mfg. (y): 1.542
Median (y): 0.946
Sample Standard Deviation (y): 0.042
Variance (y): 0.002
Mean Percent Error Mfg. (y): -22.916
% Relative Standard Deviation (y): 4.392
MSE: 0.215
Alpha: 0.05
df: (n - 2) = 7
t-value: 2.365
Confidence Interval (y): 0.964 +/- 0.033
Confidence Interval Corrected Mfg. (y): 1.542 +/- 0.053
UCL: 0.997
UCL Mfg. Corrected: 1.595
LCL: 0.931
LCL Mfg. Corrected: 1.489
Prediction Interval (y): 0.964 +/- 0.105
One-sample Mfg. t-test: t-statistic Mfg.=-19.146, p-value=5.739278824439516e-08
             Reject Mfg. Ho (ymean = u): True
################################################

########## Target 9.699 ppm Statistics ##########
n: 9
Min (y): 4.634
Max (y): 4.699
Mean (y): 4.66
Mean Corrected Mfg. (y): 7.455
Median (y): 4.648
Sample Standard Deviation (y): 0.024
Variance (y): 0.001
Mean Percent Error Mfg. (y): -23.133
% Relative Standard Deviation (y): 0.508
MSE: 5.036
Alpha: 0.05
df: (n - 2) = 7
t-value: 2.365
Confidence Interval (y): 4.66 +/- 0.019
Confidence Interval Corrected Mfg. (y): 7.455 +/- 0.03
UCL: 4.679
UCL Mfg. Corrected: 7.485
LCL: 4.641
LCL Mfg. Corrected: 7.425
Prediction Interval (y): 4.66 +/- 0.059
One-sample Mfg. t-test: t-statistic Mfg.=-167.44, p-value=1.8109575763394596e-15
             Reject Mfg. Ho (ymean = u): True
################################################
```

========== Isobutylene AreaRAE (ER) Statistics ==========

Date: 2023-05-06
Start: 08:30:04
Stop: 19:04:36

NOTE: VALUES WHICH HAVE THE ABREVIATION "MFG." HAVE THE MANUFACTURER CORRECTION FACTOR APPLIED TO THE VALUE.

########## Regression Statistics ##########
n: 106
Mean Percent Error (Mfg.): -2.997
Mean Percent Error (Assessment): -1.224
% Relative Standard Deviation (x): 223.429
% Relative Standard Deviation (y): 225.916
Standard Deviation (x): 29.762
Standard Deviation (y): 31.72
Variance (x): 885.803
Variance (y): 1006.154
Covariance (xy): 950.71
Alpha: 0.05
df: (n - 2) = 104
t-value: 1.983
Correlation Coefficient (R): 0.998
R^2: 0.995
MSE (yh): 4.943
Slope: 1.063
Slope Standard Error: 0.007
Slope p-value: 6.963402337245255e-122 (Ho: slope = 0)
y-Intercept: -0.121
y-Intercept Standard Error: 0.239
Regression Equation: y = 1.063(x) - 0.121
Confidence Interval (Slope): 1.063 +/- 0.015
UCL (Slope): 1.078
LCL (Slope): 1.048
Honeywell Correction Factor: 1
Isobutylene Calibration Slope: 0.996
Assessment Correction Factor: 0.937
##

```
########## Target 0 ppm Statistics ##########
n: 43
Min (y): 0.0
Max (y): 0.1
Mean (y): 0.026
Mean Corrected Mfg. (y): 0.026
Median (y): 0.0
Sample Standard Deviation (y): 0.044
Variance (y): 0.002
Mean Percent Error Mfg. (y): nan
% Relative Standard Deviation (y): 170.561
MSE: 0.003
Alpha: 0.05
df: (n - 2) = 41
t-value: 2.02
Confidence Interval (y): 0.026 +/- 0.013
Confidence Interval Corrected Mfg. (y): 0.026 +/- 0.013
UCL: 0.039
UCL Mfg. Corrected: 0.039
LCL: 0.013
LCL Mfg. Corrected: 0.013
Prediction Interval (y): 0.026 +/- 0.089
One-sample Mfg. t-test: t-statistic Mfg.=3.8, p-value=0.00046121504999680944
             Reject Mfg. Ho (ymean = u): True
##############################################

########## Target 10 ppm Statistics ##########
n: 26
Min (y): 9.7
Max (y): 10.6
Mean (y): 10.019
Mean Corrected Mfg. (y): 10.019
Median (y): 10.0
Sample Standard Deviation (y): 0.173
Variance (y): 0.03
Mean Percent Error Mfg. (y): 0.192
% Relative Standard Deviation (y): 1.729
MSE: 0.03
Alpha: 0.05
df: (n - 2) = 24
t-value: 2.064
Confidence Interval (y): 10.019 +/- 0.07
Confidence Interval Corrected Mfg. (y): 10.019 +/- 0.07
UCL: 10.089
UCL Mfg. Corrected: 10.089
LCL: 9.949
LCL Mfg. Corrected: 9.949
Prediction Interval (y): 10.019 +/- 0.364
One-sample Mfg. t-test: t-statistic Mfg.=0.555, p-value=0.5838216754276255
             Reject Mfg. Ho (ymean = u): False
##############################################
```

```
########## Target 100 ppm Statistics ##########
n: 11
Min (y): 96.6
Max (y): 115.3
Mean (y): 106.3
Mean Corrected Mfg. (y): 106.3
Median (y): 106.9
Sample Standard Deviation (y): 6.833
Variance (y): 46.684
Mean Percent Error Mfg. (y): 6.3
% Relative Standard Deviation (y): 6.428
MSE: 86.374
Alpha: 0.05
df: (n - 2) = 9
t-value: 2.262
Confidence Interval (y): 106.3 +/- 4.66
Confidence Interval Corrected Mfg. (y): 106.3 +/- 4.66
UCL: 110.96
UCL Mfg. Corrected: 110.96
LCL: 101.64
LCL Mfg. Corrected: 101.64
Prediction Interval (y): 106.3 +/- 16.144
One-sample Mfg. t-test: t-statistic Mfg.=2.916, p-value=0.015410817061525322
             Reject Mfg. Ho (ymean = u): True
################################################

########## Target 2 ppm Statistics ##########
n: 26
Min (y): 1.9
Max (y): 2.6
Mean (y): 2.208
Mean Corrected Mfg. (y): 2.208
Median (y): 2.2
Sample Standard Deviation (y): 0.215
Variance (y): 0.046
Mean Percent Error Mfg. (y): 10.385
% Relative Standard Deviation (y): 9.725
MSE: 0.089
Alpha: 0.05
df: (n - 2) = 24
t-value: 2.064
Confidence Interval (y): 2.208 +/- 0.087
Confidence Interval Corrected Mfg. (y): 2.208 +/- 0.087
UCL: 2.295
UCL Mfg. Corrected: 2.295
LCL: 2.121
LCL Mfg. Corrected: 2.121
Prediction Interval (y): 2.208 +/- 0.452
One-sample Mfg. t-test: t-statistic Mfg.=4.837, p-value=5.68622654219531e-05
             Reject Mfg. Ho (ymean = u): True
################################################
```

========== Isobutylene AreaRAE Pro (PPB) Statistics ==========

Date: 2023-05-04
Start: 08:26:15
Stop: 19:21:50

NOTE: VALUES WHICH HAVE THE ABREVIATION "MFG." HAVE THE MANUFACTURER CORRECTION FACTOR APPLIED TO THE VALUE.

########## Regression Statistics ##########
n: 105
Mean Percent Error (Mfg.): 6.453
Mean Percent Error (Assessment): 10.71
% Relative Standard Deviation (x): 233.281
% Relative Standard Deviation (y): 228.329
Standard Deviation (x): 27.327
Standard Deviation (y): 26.664
Variance (x): 746.776
Variance (y): 710.948
Covariance (xy): 735.463
Alpha: 0.05
df: (n - 2) = 103
t-value: 1.983
Correlation Coefficient (R): 1.0
R^2: 0.999
MSE (yh): 0.356
Slope: 0.975
Slope Standard Error: 0.002
Slope p-value: 8.969917382577411e-172 (Ho: slope = 0)
y-Intercept: 0.251
y-Intercept Standard Error: 0.064
Regression Equation: y = 0.975(x) + 0.251
Confidence Interval (Slope): 0.975 +/- 0.004
UCL (Slope): 0.979
LCL (Slope): 0.971
Honeywell Correction Factor: 1
Isobutylene Calibration Slope: 0.981
Assessment Correction Factor: 1.006
##

```
########## Target 0 ppm Statistics ##########
n: 39
Min (y): 0.0
Max (y): 0.22
Mean (y): 0.069
Mean Corrected Mfg. (y): 0.069
Median (y): 0.06
Sample Standard Deviation (y): 0.072
Variance (y): 0.005
Mean Percent Error Mfg. (y): nan
% Relative Standard Deviation (y): 103.671
MSE: 0.01
Alpha: 0.05
df: (n - 2) = 37
t-value: 2.026
Confidence Interval (y): 0.069 +/- 0.023
Confidence Interval Corrected Mfg. (y): 0.069 +/- 0.023
UCL: 0.092
UCL Mfg. Corrected: 0.092
LCL: 0.046
LCL Mfg. Corrected: 0.046
Prediction Interval (y): 0.069 +/- 0.148
One-sample Mfg. t-test: t-statistic Mfg.=5.946, p-value=6.74880305765921e-07
             Reject Mfg. Ho (ymean = u): True
##############################################

########## Target 10 ppm Statistics ##########
n: 27
Min (y): 9.65
Max (y): 10.29
Mean (y): 9.986
Mean Corrected Mfg. (y): 9.986
Median (y): 10.0
Sample Standard Deviation (y): 0.141
Variance (y): 0.02
Mean Percent Error Mfg. (y): -0.137
% Relative Standard Deviation (y): 1.413
MSE: 0.02
Alpha: 0.05
df: (n - 2) = 25
t-value: 2.06
Confidence Interval (y): 9.986 +/- 0.056
Confidence Interval Corrected Mfg. (y): 9.986 +/- 0.056
UCL: 10.042
UCL Mfg. Corrected: 10.042
LCL: 9.93
LCL Mfg. Corrected: 9.93
Prediction Interval (y): 9.986 +/- 0.296
One-sample Mfg. t-test: t-statistic Mfg.=-0.495, p-value=0.6246307600959767
             Reject Mfg. Ho (ymean = u): False
##############################################
```

```
########## Target 100 ppm Statistics ##########
n: 9
Min (y): 94.89
Max (y): 99.78
Mean (y): 97.787
Mean Corrected Mfg. (y): 97.787
Median (y): 98.68
Sample Standard Deviation (y): 1.917
Variance (y): 3.676
Mean Percent Error Mfg. (y): -2.213
% Relative Standard Deviation (y): 1.961
MSE: 8.575
Alpha: 0.05
df: (n - 2) = 7
t-value: 2.365
Confidence Interval (y): 97.787 +/- 1.511
Confidence Interval Corrected Mfg. (y): 97.787 +/- 1.511
UCL: 99.298
UCL Mfg. Corrected: 99.298
LCL: 96.276
LCL Mfg. Corrected: 96.276
Prediction Interval (y): 97.787 +/- 4.779
One-sample Mfg. t-test: t-statistic Mfg.=-3.265, p-value=0.011436366311307265
             Reject Mfg. Ho (ymean = u): True
################################################

########## Target 2 ppm Statistics ##########
n: 30
Min (y): 2.24
Max (y): 2.67
Mean (y): 2.458
Mean Corrected Mfg. (y): 2.458
Median (y): 2.465
Sample Standard Deviation (y): 0.107
Variance (y): 0.011
Mean Percent Error Mfg. (y): 22.9
% Relative Standard Deviation (y): 4.348
MSE: 0.221
Alpha: 0.05
df: (n - 2) = 28
t-value: 2.048
Confidence Interval (y): 2.458 +/- 0.04
Confidence Interval Corrected Mfg. (y): 2.458 +/- 0.04
UCL: 2.498
UCL Mfg. Corrected: 2.498
LCL: 2.418
LCL Mfg. Corrected: 2.418
Prediction Interval (y): 2.458 +/- 0.223
One-sample Mfg. t-test: t-statistic Mfg.=23.077, p-value=3.2837961845608124e-20
             Reject Mfg. Ho (ymean = u): True
############################################
```

============== Isobutylene Calibration AreaRAE (ER) Statistics ==============

Date: 2023-05-06
Start: 08:30:04
Stop: 19:04:36

NOTE: VALUES WHICH HAVE THE ABREVIATION "MFG." HAVE THE MANUFACTURER
CORRECTION FACTOR APPLIED TO THE VALUE.

########## Regression Statistics ##########
n: 95
Mean Percent Error (Mfg.): 3.098
Mean Percent Error (Assessment): 5.288
% Relative Standard Deviation (x): 128.019
% Relative Standard Deviation (y): 124.774
Standard Deviation (x): 4.204
Standard Deviation (y): 4.19
Variance (x): 17.677
Variance (y): 17.554
Covariance (xy): 17.789
Alpha: 0.05
df: (n - 2) = 93
t-value: 1.986
Correlation Coefficient (R): 0.999
R^2: 0.998
MSE (yh): 0.028
Slope: 0.996
Slope Standard Error: 0.004
Slope p-value: 8.865106073596238e-132 (Ho: slope = 0)
y-Intercept: 0.088
y-Intercept Standard Error: 0.022
Regression Equation: y = 0.996(x) + 0.088
Confidence Interval (Slope): 0.996 +/- 0.008
UCL (Slope): 1.004
LCL (Slope): 0.988
Honeywell Correction Factor: 1
Isobutylene Calibration Slope: 0.996
Assessment Correction Factor: 1.0
##

```
########## Target 0 ppm Statistics ##########
n: 43
Min (y): 0.0
Max (y): 0.1
Mean (y): 0.026
Mean Corrected Mfg. (y): 0.026
Median (y): 0.0
Sample Standard Deviation (y): 0.044
Variance (y): 0.002
Mean Percent Error Mfg. (y): nan
% Relative Standard Deviation (y): 170.561
MSE: 0.003
Alpha: 0.05
df: (n - 2) = 41
t-value: 2.02
Confidence Interval (y): 0.026 +/- 0.013
Confidence Interval Corrected Mfg. (y): 0.026 +/- 0.013
UCL: 0.039
UCL Mfg. Corrected: 0.039
LCL: 0.013
LCL Mfg. Corrected: 0.013
Prediction Interval (y): 0.026 +/- 0.089
One-sample Mfg. t-test: t-statistic Mfg.=3.8, p-value=0.00046121504999680944
             Reject Mfg. Ho (ymean = u): True
##############################################

########## Target 10 ppm Statistics ##########
n: 26
Min (y): 9.7
Max (y): 10.6
Mean (y): 10.019
Mean Corrected Mfg. (y): 10.019
Median (y): 10.0
Sample Standard Deviation (y): 0.173
Variance (y): 0.03
Mean Percent Error Mfg. (y): 0.192
% Relative Standard Deviation (y): 1.729
MSE: 0.03
Alpha: 0.05
df: (n - 2) = 24
t-value: 2.064
Confidence Interval (y): 10.019 +/- 0.07
Confidence Interval Corrected Mfg. (y): 10.019 +/- 0.07
UCL: 10.089
UCL Mfg. Corrected: 10.089
LCL: 9.949
LCL Mfg. Corrected: 9.949
Prediction Interval (y): 10.019 +/- 0.364
One-sample Mfg. t-test: t-statistic Mfg.=0.555, p-value=0.5838216754276255
             Reject Mfg. Ho (ymean = u): False
##############################################
```

```
########## Target 2 ppm Statistics ##########
n: 26
Min (y): 1.9
Max (y): 2.6
Mean (y): 2.208
Mean Corrected Mfg. (y): 2.208
Median (y): 2.2
Sample Standard Deviation (y): 0.215
Variance (y): 0.046
Mean Percent Error Mfg. (y): 10.385
% Relative Standard Deviation (y): 9.725
MSE: 0.089
Alpha: 0.05
df: (n - 2) = 24
t-value: 2.064
Confidence Interval (y): 2.208 +/- 0.087
Confidence Interval Corrected Mfg. (y): 2.208 +/- 0.087
UCL: 2.295
UCL Mfg. Corrected: 2.295
LCL: 2.121
LCL Mfg. Corrected: 2.121
Prediction Interval (y): 2.208 +/- 0.452
One-sample Mfg. t-test: t-statistic Mfg.=4.837, p-value=5.68622654219531e-05
             Reject Mfg. Ho (ymean = u): True
##############################################
```

========== Isobutylene Calibration AreaRAE Pro (PPB) Statistics ==========

Date: 2023-05-04
Start: 08:26:15
Stop: 19:21:50

NOTE: VALUES WHICH HAVE THE ABREVIATION "MFG." HAVE THE MANUFACTURER CORRECTION FACTOR APPLIED TO THE VALUE.

########## Regression Statistics ##########
n: 96
Mean Percent Error (Mfg.): 6.787
Mean Percent Error (Assessment): 11.988
% Relative Standard Deviation (x): 121.9
% Relative Standard Deviation (y): 114.214
Standard Deviation (x): 4.19
Standard Deviation (y): 4.117
Variance (x): 17.559
Variance (y): 16.953
Covariance (xy): 17.412
Alpha: 0.05
df: (n - 2) = 94
t-value: 1.986
Correlation Coefficient (R): 0.999
R^2: 0.997
MSE (yh): 0.045
Slope: 0.981
Slope Standard Error: 0.005
Slope p-value: 4.8418143292249964e-123 (Ho: slope = 0)
y-Intercept: 0.232
y-Intercept Standard Error: 0.028
Regression Equation: y = 0.981(x) + 0.232
Confidence Interval (Slope): 0.981 +/- 0.01
UCL (Slope): 0.991
LCL (Slope): 0.971
Honeywell Correction Factor: 1
Isobutylene Calibration Slope: 0.981
Assessment Correction Factor: 1.0
##

```
########## Target 0 ppm Statistics ##########
n: 39
Min (y): 0.0
Max (y): 0.22
Mean (y): 0.069
Mean Corrected Mfg. (y): 0.069
Median (y): 0.06
Sample Standard Deviation (y): 0.072
Variance (y): 0.005
Mean Percent Error Mfg. (y): nan
% Relative Standard Deviation (y): 103.671
MSE: 0.01
Alpha: 0.05
df: (n - 2) = 37
t-value: 2.026
Confidence Interval (y): 0.069 +/- 0.023
Confidence Interval Corrected Mfg. (y): 0.069 +/- 0.023
UCL: 0.092
UCL Mfg. Corrected: 0.092
LCL: 0.046
LCL Mfg. Corrected: 0.046
Prediction Interval (y): 0.069 +/- 0.148
One-sample Mfg. t-test: t-statistic Mfg.=5.946, p-value=6.74880305765921e-07
             Reject Mfg. Ho (ymean = u): True
##############################################

########## Target 10 ppm Statistics ##########
n: 27
Min (y): 9.65
Max (y): 10.29
Mean (y): 9.986
Mean Corrected Mfg. (y): 9.986
Median (y): 10.0
Sample Standard Deviation (y): 0.141
Variance (y): 0.02
Mean Percent Error Mfg. (y): -0.137
% Relative Standard Deviation (y): 1.413
MSE: 0.02
Alpha: 0.05
df: (n - 2) = 25
t-value: 2.06
Confidence Interval (y): 9.986 +/- 0.056
Confidence Interval Corrected Mfg. (y): 9.986 +/- 0.056
UCL: 10.042
UCL Mfg. Corrected: 10.042
LCL: 9.93
LCL Mfg. Corrected: 9.93
Prediction Interval (y): 9.986 +/- 0.296
One-sample Mfg. t-test: t-statistic Mfg.=-0.495, p-value=0.6246307600959767
             Reject Mfg. Ho (ymean = u): False
##############################################
```

```
########## Target 2 ppm Statistics ##########
n: 30
Min (y): 2.24
Max (y): 2.67
Mean (y): 2.458
Mean Corrected Mfg. (y): 2.458
Median (y): 2.465
Sample Standard Deviation (y): 0.107
Variance (y): 0.011
Mean Percent Error Mfg. (y): 22.9
% Relative Standard Deviation (y): 4.348
MSE: 0.221
Alpha: 0.05
df: (n - 2) = 28
t-value: 2.048
Confidence Interval (y): 2.458 +/- 0.04
Confidence Interval Corrected Mfg. (y): 2.458 +/- 0.04
UCL: 2.498
UCL Mfg. Corrected: 2.498
LCL: 2.418
LCL Mfg. Corrected: 2.418
Prediction Interval (y): 2.458 +/- 0.223
One-sample Mfg. t-test: t-statistic Mfg.=23.077, p-value=3.2837961845608124e-20
             Reject Mfg. Ho (ymean = u): True
##############################################
```

========== Isobutylene Calibration MultiRAE Pro (ER) Statistics ==========

Date: 2023-05-05
Start: 08:10:00
Stop: 18:51:00

NOTE: VALUES WHICH HAVE THE ABREVIATION "MFG." HAVE THE MANUFACTURER CORRECTION FACTOR APPLIED TO THE VALUE.

########## Regression Statistics ##########
n: 81
Mean Percent Error (Mfg.): -0.111
Mean Percent Error (Assessment): 0.178
% Relative Standard Deviation (x): 134.999
% Relative Standard Deviation (y): 134.24
Standard Deviation (x): 3.9
Standard Deviation (y): 3.89
Variance (x): 15.21
Variance (y): 15.129
Covariance (xy): 15.355
Alpha: 0.05
df: (n - 2) = 79
t-value: 1.99
Correlation Coefficient (R): 1.0
R^2: 0.999
MSE (yh): 0.009
Slope: 0.997
Slope Standard Error: 0.003
Slope p-value: 1.4725162334272577e-129 (Ho: slope = 0)
y-Intercept: 0.017
y-Intercept Standard Error: 0.013
Regression Equation: y = 0.997(x) + 0.017
Confidence Interval (Slope): 0.997 +/- 0.005
UCL (Slope): 1.002
LCL (Slope): 0.992
Honeywell Correction Factor: 1
Isobutylene Calibration Slope: 0.997
Assessment Correction Factor: 1.0
##

```
########## Target 0 ppm Statistics ##########
n: 36
Min (y): 0.0
Max (y): 0.1
Mean (y): 0.019
Mean Corrected Mfg. (y): 0.019
Median (y): 0.0
Sample Standard Deviation (y): 0.04
Variance (y): 0.002
Mean Percent Error Mfg. (y): nan
% Relative Standard Deviation (y): 203.54
MSE: 0.002
Alpha: 0.05
df: (n - 2) = 34
t-value: 2.032
Confidence Interval (y): 0.019 +/- 0.013
Confidence Interval Corrected Mfg. (y): 0.019 +/- 0.013
UCL: 0.032
UCL Mfg. Corrected: 0.032
LCL: 0.006
LCL Mfg. Corrected: 0.006
Prediction Interval (y): 0.019 +/- 0.082
One-sample Mfg. t-test: t-statistic Mfg.=2.907, p-value=0.0063000042296935226
             Reject Mfg. Ho (ymean = u): True
##############################################

########## Target 10 ppm Statistics ##########
n: 18
Min (y): 9.7
Max (y): 10.4
Mean (y): 9.989
Mean Corrected Mfg. (y): 9.989
Median (y): 10.0
Sample Standard Deviation (y): 0.17
Variance (y): 0.029
Mean Percent Error Mfg. (y): -0.111
% Relative Standard Deviation (y): 1.698
MSE: 0.029
Alpha: 0.05
df: (n - 2) = 16
t-value: 2.12
Confidence Interval (y): 9.989 +/- 0.085
Confidence Interval Corrected Mfg. (y): 9.989 +/- 0.085
UCL: 10.074
UCL Mfg. Corrected: 10.074
LCL: 9.904
LCL Mfg. Corrected: 9.904
Prediction Interval (y): 9.989 +/- 0.369
One-sample Mfg. t-test: t-statistic Mfg.=-0.27, p-value=0.7903245519800054
             Reject Mfg. Ho (ymean = u): False
##############################################
```

```
########## Target 2 ppm Statistics ##########
n: 27
Min (y): 1.8
Max (y): 2.2
Mean (y): 2.007
Mean Corrected Mfg. (y): 2.007
Median (y): 2.0
Sample Standard Deviation (y): 0.072
Variance (y): 0.005
Mean Percent Error Mfg. (y): 0.37
% Relative Standard Deviation (y): 3.568
MSE: 0.005
Alpha: 0.05
df: (n - 2) = 25
t-value: 2.06
Confidence Interval (y): 2.007 +/- 0.028
Confidence Interval Corrected Mfg. (y): 2.007 +/- 0.028
UCL: 2.035
UCL Mfg. Corrected: 2.035
LCL: 1.979
LCL Mfg. Corrected: 1.979
Prediction Interval (y): 2.007 +/- 0.15
One-sample Mfg. t-test: t-statistic Mfg.=0.527, p-value=0.602436996703086
             Reject Mfg. Ho (ymean = u): False
##############################################
```

========== Isobutylene Calibration MultiRAE Pro (PPB) Statistics ==========

Date: 2023-05-03
Start: 09:58:00
Stop: 15:49:38

NOTE: VALUES WHICH HAVE THE ABREVIATION "MFG." HAVE THE MANUFACTURER CORRECTION FACTOR APPLIED TO THE VALUE.

########## Regression Statistics ##########
n: 66
Mean Percent Error (Mfg.): 0.973
Mean Percent Error (Assessment): -1.569
% Relative Standard Deviation (x): 106.854
% Relative Standard Deviation (y): 105.792
Standard Deviation (x): 4.468
Standard Deviation (y): 4.307
Variance (x): 19.967
Variance (y): 18.548
Covariance (xy): 19.517
Alpha: 0.05
df: (n - 2) = 64
t-value: 1.998
Correlation Coefficient (R): 0.999
R^2: 0.998
MSE (yh): 0.044
Slope: 0.963
Slope Standard Error: 0.006
Slope p-value: 1.0002919805371664e-85 (Ho: slope = 0)
y-Intercept: 0.045
y-Intercept Standard Error: 0.036
Regression Equation: y = 0.963(x) + 0.045
Confidence Interval (Slope): 0.963 +/- 0.012
UCL (Slope): 0.975
LCL (Slope): 0.951
Honeywell Correction Factor: 1
Isobutylene Calibration Slope: 0.963
Assessment Correction Factor: 1.0
##

```
########## Target 0 ppm Statistics ##########
n: 24
Min (y): 0.0
Max (y): 0.06
Mean (y): 0.018
Mean Corrected Mfg. (y): 0.018
Median (y): 0.0
Sample Standard Deviation (y): 0.023
Variance (y): 0.001
Mean Percent Error Mfg. (y): nan
% Relative Standard Deviation (y): 128.876
MSE: 0.001
Alpha: 0.05
df: (n - 2) = 22
t-value: 2.074
Confidence Interval (y): 0.018 +/- 0.01
Confidence Interval Corrected Mfg. (y): 0.018 +/- 0.01
UCL: 0.028
UCL Mfg. Corrected: 0.028
LCL: 0.008
LCL Mfg. Corrected: 0.008
Prediction Interval (y): 0.018 +/- 0.049
One-sample Mfg. t-test: t-statistic Mfg.=3.721, p-value=0.0011210095696795798
             Reject Mfg. Ho (ymean = u): True
##############################################

########## Target 10 ppm Statistics ##########
n: 24
Min (y): 8.65
Max (y): 10.1
Mean (y): 9.665
Mean Corrected Mfg. (y): 9.665
Median (y): 9.76
Sample Standard Deviation (y): 0.34
Variance (y): 0.116
Mean Percent Error Mfg. (y): -3.35
% Relative Standard Deviation (y): 3.518
MSE: 0.228
Alpha: 0.05
df: (n - 2) = 22
t-value: 2.074
Confidence Interval (y): 9.665 +/- 0.144
Confidence Interval Corrected Mfg. (y): 9.665 +/- 0.144
UCL: 9.809
UCL Mfg. Corrected: 9.809
LCL: 9.521
LCL Mfg. Corrected: 9.521
Prediction Interval (y): 9.665 +/- 0.72
One-sample Mfg. t-test: t-statistic Mfg.=-4.725, p-value=9.239095222649929e-05
             Reject Mfg. Ho (ymean = u): True
##############################################
```

```
########## Target 2 ppm Statistics ##########
n: 18
Min (y): 1.87
Max (y): 2.11
Mean (y): 2.016
Mean Corrected Mfg. (y): 2.016
Median (y): 2.02
Sample Standard Deviation (y): 0.057
Variance (y): 0.003
Mean Percent Error Mfg. (y): 0.806
% Relative Standard Deviation (y): 2.85
MSE: 0.004
Alpha: 0.05
df: (n - 2) = 16
t-value: 2.12
Confidence Interval (y): 2.016 +/- 0.029
Confidence Interval Corrected Mfg. (y): 2.016 +/- 0.029
UCL: 2.045
UCL Mfg. Corrected: 2.045
LCL: 1.987
LCL Mfg. Corrected: 1.987
Prediction Interval (y): 2.016 +/- 0.125
One-sample Mfg. t-test: t-statistic Mfg.=1.156, p-value=0.2636339697648237
             Reject Mfg. Ho (ymean = u): False
##############################################
```

============== Isobutylene Calibration ppbRAE 3000 Statistics ==============

Date: 2023-05-06
Start: 08:43:00
Stop: 17:11:10

NOTE: VALUES WHICH HAVE THE ABREVIATION "MFG." HAVE THE MANUFACTURER
CORRECTION FACTOR APPLIED TO THE VALUE.

########## Regression Statistics ##########
n: 88
Mean Percent Error (Mfg.): 2.148
Mean Percent Error (Assessment): -7.86
% Relative Standard Deviation (x): 121.794
% Relative Standard Deviation (y): 119.452
Standard Deviation (x): 4.207
Standard Deviation (y): 3.719
Variance (x): 17.702
Variance (y): 13.832
Covariance (xy): 15.805
Alpha: 0.05
df: (n - 2) = 86
t-value: 1.988
Correlation Coefficient (R): 0.999
R^2: 0.997
MSE (yh): 0.039
Slope: 0.883
Slope Standard Error: 0.005
Slope p-value: 2.392376148026878e-111 (Ho: slope = 0)
y-Intercept: 0.064
y-Intercept Standard Error: 0.028
Regression Equation: y = 0.883(x) + 0.064
Confidence Interval (Slope): 0.883 +/- 0.01
UCL (Slope): 0.893
LCL (Slope): 0.873
Honeywell Correction Factor: 1
Isobutylene Calibration Slope: 0.883
Assessment Correction Factor: 1.0
##

```
########## Target 0 ppm Statistics ##########
n: 36
Min (y): 0.0
Max (y): 0.135
Mean (y): 0.019
Mean Corrected Mfg. (y): 0.019
Median (y): 0.0
Sample Standard Deviation (y): 0.035
Variance (y): 0.001
Mean Percent Error Mfg. (y): nan
% Relative Standard Deviation (y): 191.254
MSE: 0.002
Alpha: 0.05
df: (n - 2) = 34
t-value: 2.032
Confidence Interval (y): 0.019 +/- 0.012
Confidence Interval Corrected Mfg. (y): 0.019 +/- 0.012
UCL: 0.031
UCL Mfg. Corrected: 0.031
LCL: 0.007
LCL Mfg. Corrected: 0.007
Prediction Interval (y): 0.019 +/- 0.073
One-sample Mfg. t-test: t-statistic Mfg.=3.093, p-value=0.0038753763498151086
             Reject Mfg. Ho (ymean = u): True
##############################################

########## Target 10 ppm Statistics ##########
n: 25
Min (y): 7.966
Max (y): 9.302
Mean (y): 8.875
Mean Corrected Mfg. (y): 8.875
Median (y): 8.929
Sample Standard Deviation (y): 0.314
Variance (y): 0.099
Mean Percent Error Mfg. (y): -11.254
% Relative Standard Deviation (y): 3.538
MSE: 1.365
Alpha: 0.05
df: (n - 2) = 23
t-value: 2.069
Confidence Interval (y): 8.875 +/- 0.13
Confidence Interval Corrected Mfg. (y): 8.875 +/- 0.13
UCL: 9.005
UCL Mfg. Corrected: 9.005
LCL: 8.745
LCL Mfg. Corrected: 8.745
Prediction Interval (y): 8.875 +/- 0.662
One-sample Mfg. t-test: t-statistic Mfg.=-17.558, p-value=3.3651217028821588e-15
             Reject Mfg. Ho (ymean = u): True
##############################################
```

```
########## Target 2 ppm Statistics ##########
n: 27
Min (y): 1.409
Max (y): 2.087
Mean (y): 1.906
Mean Corrected Mfg. (y): 1.906
Median (y): 1.966
Sample Standard Deviation (y): 0.161
Variance (y): 0.026
Mean Percent Error Mfg. (y): -4.717
% Relative Standard Deviation (y): 8.446
MSE: 0.035
Alpha: 0.05
df: (n - 2) = 25
t-value: 2.06
Confidence Interval (y): 1.906 +/- 0.064
Confidence Interval Corrected Mfg. (y): 1.906 +/- 0.064
UCL: 1.97
UCL Mfg. Corrected: 1.97
LCL: 1.842
LCL Mfg. Corrected: 1.842
Prediction Interval (y): 1.906 +/- 0.338
One-sample Mfg. t-test: t-statistic Mfg.=-2.989, p-value=0.006049566335428046
             Reject Mfg. Ho (ymean = u): True
##############################################
```

========== Isobutylene MultiRAE Pro (ER) Statistics ==========

Date: 2023-05-05
Start: 08:10:00
Stop: 18:51:00

NOTE: VALUES WHICH HAVE THE ABREVIATION "MFG." HAVE THE MANUFACTURER CORRECTION FACTOR APPLIED TO THE VALUE.

########## Regression Statistics ##########
n: 90
Mean Percent Error (Mfg.): -22.485
Mean Percent Error (Assessment): -22.224
% Relative Standard Deviation (x): 233.074
% Relative Standard Deviation (y): 247.636
Standard Deviation (x): 29.367
Standard Deviation (y): 40.015
Variance (x): 862.44
Variance (y): 1601.22
Covariance (xy): 1185.868
Alpha: 0.05
df: (n - 2) = 88
t-value: 1.987
Correlation Coefficient (R): 0.998
R^2: 0.996
MSE (yh): 6.669
Slope: 1.36
Slope Standard Error: 0.009
Slope p-value: 1.5538904995541355e-106 (Ho: slope = 0)
y-Intercept: -0.974
y-Intercept Standard Error: 0.3
Regression Equation: y = 1.36(x) - 0.974
Confidence Interval (Slope): 1.36 +/- 0.019
UCL (Slope): 1.379
LCL (Slope): 1.341
Honeywell Correction Factor: 1
Isobutylene Calibration Slope: 0.997
Assessment Correction Factor: 0.733
##

```
########## Target 0 ppm Statistics ##########
n: 36
Min (y): 0.0
Max (y): 0.1
Mean (y): 0.019
Mean Corrected Mfg. (y): 0.019
Median (y): 0.0
Sample Standard Deviation (y): 0.04
Variance (y): 0.002
Mean Percent Error Mfg. (y): nan
% Relative Standard Deviation (y): 203.54
MSE: 0.002
Alpha: 0.05
df: (n - 2) = 34
t-value: 2.032
Confidence Interval (y): 0.019 +/- 0.013
Confidence Interval Corrected Mfg. (y): 0.019 +/- 0.013
UCL: 0.032
UCL Mfg. Corrected: 0.032
LCL: 0.006
LCL Mfg. Corrected: 0.006
Prediction Interval (y): 0.019 +/- 0.082
One-sample Mfg. t-test: t-statistic Mfg.=2.907, p-value=0.0063000042296935226
             Reject Mfg. Ho (ymean = u): True
##############################################

########## Target 10 ppm Statistics ##########
n: 18
Min (y): 9.7
Max (y): 10.4
Mean (y): 9.989
Mean Corrected Mfg. (y): 9.989
Median (y): 10.0
Sample Standard Deviation (y): 0.17
Variance (y): 0.029
Mean Percent Error Mfg. (y): -0.111
% Relative Standard Deviation (y): 1.698
MSE: 0.029
Alpha: 0.05
df: (n - 2) = 16
t-value: 2.12
Confidence Interval (y): 9.989 +/- 0.085
Confidence Interval Corrected Mfg. (y): 9.989 +/- 0.085
UCL: 10.074
UCL Mfg. Corrected: 10.074
LCL: 9.904
LCL Mfg. Corrected: 9.904
Prediction Interval (y): 9.989 +/- 0.369
One-sample Mfg. t-test: t-statistic Mfg.=-0.27, p-value=0.7903245519800054
             Reject Mfg. Ho (ymean = u): False
##############################################
```

```
########## Target 100 ppm Statistics ##########
n: 9
Min (y): 128.7
Max (y): 145.8
Mean (y): 135.511
Mean Corrected Mfg. (y): 135.511
Median (y): 132.2
Sample Standard Deviation (y): 6.951
Variance (y): 48.312
Mean Percent Error Mfg. (y): 35.511
% Relative Standard Deviation (y): 5.129
MSE: 1309.351
Alpha: 0.05
df: (n - 2) = 7
t-value: 2.365
Confidence Interval (y): 135.511 +/- 5.479
Confidence Interval Corrected Mfg. (y): 135.511 +/- 5.479
UCL: 140.99
UCL Mfg. Corrected: 140.99
LCL: 130.032
LCL Mfg. Corrected: 130.032
Prediction Interval (y): 135.511 +/- 17.325
One-sample Mfg. t-test: t-statistic Mfg.=14.45, p-value=5.144814887356584e-07
             Reject Mfg. Ho (ymean = u): True
################################################

########## Target 2 ppm Statistics ##########
n: 27
Min (y): 1.8
Max (y): 2.2
Mean (y): 2.007
Mean Corrected Mfg. (y): 2.007
Median (y): 2.0
Sample Standard Deviation (y): 0.072
Variance (y): 0.005
Mean Percent Error Mfg. (y): 0.37
% Relative Standard Deviation (y): 3.568
MSE: 0.005
Alpha: 0.05
df: (n - 2) = 25
t-value: 2.06
Confidence Interval (y): 2.007 +/- 0.028
Confidence Interval Corrected Mfg. (y): 2.007 +/- 0.028
UCL: 2.035
UCL Mfg. Corrected: 2.035
LCL: 1.979
LCL Mfg. Corrected: 1.979
Prediction Interval (y): 2.007 +/- 0.15
One-sample Mfg. t-test: t-statistic Mfg.=0.527, p-value=0.602436996703086
             Reject Mfg. Ho (ymean = u): False
################################################
```

========== Isobutylene MultiRAE Pro (PPB) Statistics ==========

Date: 2023-05-03
Start: 09:58:00
Stop: 15:49:38

NOTE: VALUES WHICH HAVE THE ABREVIATION "MFG." HAVE THE MANUFACTURER CORRECTION FACTOR APPLIED TO THE VALUE.

########## Regression Statistics ##########
n: 78
Mean Percent Error (Mfg.): -5.03
Mean Percent Error (Assessment): -7.611
% Relative Standard Deviation (x): 183.981
% Relative Standard Deviation (y): 187.433
Standard Deviation (x): 34.815
Standard Deviation (y): 36.327
Variance (x): 1212.071
Variance (y): 1319.661
Covariance (xy): 1273.925
Alpha: 0.05
df: (n - 2) = 76
t-value: 1.992
Correlation Coefficient (R): 0.994
R^2: 0.989
MSE (yh): 14.838
Slope: 1.038
Slope Standard Error: 0.013
Slope p-value: 7.886977661534877e-76 (Ho: slope = 0)
y-Intercept: -0.252
y-Intercept Standard Error: 0.503
Regression Equation: y = 1.038(x) - 0.252
Confidence Interval (Slope): 1.038 +/- 0.025
UCL (Slope): 1.063
LCL (Slope): 1.013
Honeywell Correction Factor: 1
Isobutylene Calibration Slope: 0.963
Assessment Correction Factor: 0.928
##

```
########## Target 0 ppm Statistics ##########
n: 24
Min (y): 0.0
Max (y): 0.06
Mean (y): 0.018
Mean Corrected Mfg. (y): 0.018
Median (y): 0.0
Sample Standard Deviation (y): 0.023
Variance (y): 0.001
Mean Percent Error Mfg. (y): nan
% Relative Standard Deviation (y): 128.876
MSE: 0.001
Alpha: 0.05
df: (n - 2) = 22
t-value: 2.074
Confidence Interval (y): 0.018 +/- 0.01
Confidence Interval Corrected Mfg. (y): 0.018 +/- 0.01
UCL: 0.028
UCL Mfg. Corrected: 0.028
LCL: 0.008
LCL Mfg. Corrected: 0.008
Prediction Interval (y): 0.018 +/- 0.049
One-sample Mfg. t-test: t-statistic Mfg.=3.721, p-value=0.0011210095696795798
             Reject Mfg. Ho (ymean = u): True
##############################################

########## Target 10 ppm Statistics ##########
n: 24
Min (y): 8.65
Max (y): 10.1
Mean (y): 9.665
Mean Corrected Mfg. (y): 9.665
Median (y): 9.76
Sample Standard Deviation (y): 0.34
Variance (y): 0.116
Mean Percent Error Mfg. (y): -3.35
% Relative Standard Deviation (y): 3.518
MSE: 0.228
Alpha: 0.05
df: (n - 2) = 22
t-value: 2.074
Confidence Interval (y): 9.665 +/- 0.144
Confidence Interval Corrected Mfg. (y): 9.665 +/- 0.144
UCL: 9.809
UCL Mfg. Corrected: 9.809
LCL: 9.521
LCL Mfg. Corrected: 9.521
Prediction Interval (y): 9.665 +/- 0.72
One-sample Mfg. t-test: t-statistic Mfg.=-4.725, p-value=9.239095222649929e-05
             Reject Mfg. Ho (ymean = u): True
##############################################
```

```
########## Target 100 ppm Statistics ##########
n: 12
Min (y): 91.64
Max (y): 118.0
Mean (y): 103.589
Mean Corrected Mfg. (y): 103.589
Median (y): 101.81
Sample Standard Deviation (y): 9.776
Variance (y): 95.579
Mean Percent Error Mfg. (y): 3.589
% Relative Standard Deviation (y): 9.438
MSE: 108.461
Alpha: 0.05
df: (n - 2) = 10
t-value: 2.228
Confidence Interval (y): 103.589 +/- 6.288
Confidence Interval Corrected Mfg. (y): 103.589 +/- 6.288
UCL: 109.877
UCL Mfg. Corrected: 109.877
LCL: 97.301
LCL Mfg. Corrected: 97.301
Prediction Interval (y): 103.589 +/- 22.673
One-sample Mfg. t-test: t-statistic Mfg.=1.218, p-value=0.24884611388755845
             Reject Mfg. Ho (ymean = u): False
################################################

########## Target 2 ppm Statistics ##########
n: 18
Min (y): 1.87
Max (y): 2.11
Mean (y): 2.016
Mean Corrected Mfg. (y): 2.016
Median (y): 2.02
Sample Standard Deviation (y): 0.057
Variance (y): 0.003
Mean Percent Error Mfg. (y): 0.806
% Relative Standard Deviation (y): 2.85
MSE: 0.004
Alpha: 0.05
df: (n - 2) = 16
t-value: 2.12
Confidence Interval (y): 2.016 +/- 0.029
Confidence Interval Corrected Mfg. (y): 2.016 +/- 0.029
UCL: 2.045
UCL Mfg. Corrected: 2.045
LCL: 1.987
LCL Mfg. Corrected: 1.987
Prediction Interval (y): 2.016 +/- 0.125
One-sample Mfg. t-test: t-statistic Mfg.=1.156, p-value=0.2636339697648237
             Reject Mfg. Ho (ymean = u): False
################################################
```

========== Isobutylene ppbRAE 3000 Statistics ==========

Date: 2023-05-06
Start: 08:43:00
Stop: 17:11:10

NOTE: VALUES WHICH HAVE THE ABREVIATION "MFG." HAVE THE MANUFACTURER CORRECTION FACTOR APPLIED TO THE VALUE.

########## Regression Statistics ##########
n: 100
Mean Percent Error (Mfg.): -5.042
Mean Percent Error (Assessment): -14.565
% Relative Standard Deviation (x): 210.245
% Relative Standard Deviation (y): 214.045
Standard Deviation (x): 31.621
Standard Deviation (y): 30.478
Variance (x): 999.878
Variance (y): 928.904
Covariance (xy): 968.667
Alpha: 0.05
df: (n - 2) = 98
t-value: 1.984
Correlation Coefficient (R): 0.995
R^2: 0.99
MSE (yh): 9.15
Slope: 0.959
Slope Standard Error: 0.01
Slope p-value: 3.850674031506122e-100 (Ho: slope = 0)
y-Intercept: -0.186
y-Intercept Standard Error: 0.338
Regression Equation: y = 0.959(x) - 0.186
Confidence Interval (Slope): 0.959 +/- 0.019
UCL (Slope): 0.978
LCL (Slope): 0.94
Honeywell Correction Factor: 1
Isobutylene Calibration Slope: 0.883
Assessment Correction Factor: 0.92
##

```
########## Target 0 ppm Statistics ##########
n: 36
Min (y): 0.0
Max (y): 0.135
Mean (y): 0.019
Mean Corrected Mfg. (y): 0.019
Median (y): 0.0
Sample Standard Deviation (y): 0.035
Variance (y): 0.001
Mean Percent Error Mfg. (y): nan
% Relative Standard Deviation (y): 191.254
MSE: 0.002
Alpha: 0.05
df: (n - 2) = 34
t-value: 2.032
Confidence Interval (y): 0.019 +/- 0.012
Confidence Interval Corrected Mfg. (y): 0.019 +/- 0.012
UCL: 0.031
UCL Mfg. Corrected: 0.031
LCL: 0.007
LCL Mfg. Corrected: 0.007
Prediction Interval (y): 0.019 +/- 0.073
One-sample Mfg. t-test: t-statistic Mfg.=3.093, p-value=0.0038753763498151086
             Reject Mfg. Ho (ymean = u): True
##############################################

########## Target 10 ppm Statistics ##########
n: 25
Min (y): 7.966
Max (y): 9.302
Mean (y): 8.875
Mean Corrected Mfg. (y): 8.875
Median (y): 8.929
Sample Standard Deviation (y): 0.314
Variance (y): 0.099
Mean Percent Error Mfg. (y): -11.254
% Relative Standard Deviation (y): 3.538
MSE: 1.365
Alpha: 0.05
df: (n - 2) = 23
t-value: 2.069
Confidence Interval (y): 8.875 +/- 0.13
Confidence Interval Corrected Mfg. (y): 8.875 +/- 0.13
UCL: 9.005
UCL Mfg. Corrected: 9.005
LCL: 8.745
LCL Mfg. Corrected: 8.745
Prediction Interval (y): 8.875 +/- 0.662
One-sample Mfg. t-test: t-statistic Mfg.=-17.558, p-value=3.3651217028821588e-15
             Reject Mfg. Ho (ymean = u): True
##############################################
```

```
########## Target 100 ppm Statistics ##########
n: 12
Min (y): 84.34
Max (y): 107.1
Mean (y): 95.827
Mean Corrected Mfg. (y): 95.827
Median (y): 95.49
Sample Standard Deviation (y): 8.671
Variance (y): 75.19
Mean Percent Error Mfg. (y): -4.173
% Relative Standard Deviation (y): 9.049
MSE: 92.606
Alpha: 0.05
df: (n - 2) = 10
t-value: 2.228
Confidence Interval (y): 95.827 +/- 5.577
Confidence Interval Corrected Mfg. (y): 95.827 +/- 5.577
UCL: 101.404
UCL Mfg. Corrected: 101.404
LCL: 90.25
LCL Mfg. Corrected: 90.25
Prediction Interval (y): 95.827 +/- 20.11
One-sample Mfg. t-test: t-statistic Mfg.=-1.596, p-value=0.13873969333085903
             Reject Mfg. Ho (ymean = u): False
################################################

########## Target 2 ppm Statistics ##########
n: 27
Min (y): 1.409
Max (y): 2.087
Mean (y): 1.906
Mean Corrected Mfg. (y): 1.906
Median (y): 1.966
Sample Standard Deviation (y): 0.161
Variance (y): 0.026
Mean Percent Error Mfg. (y): -4.717
% Relative Standard Deviation (y): 8.446
MSE: 0.035
Alpha: 0.05
df: (n - 2) = 25
t-value: 2.06
Confidence Interval (y): 1.906 +/- 0.064
Confidence Interval Corrected Mfg. (y): 1.906 +/- 0.064
UCL: 1.97
UCL Mfg. Corrected: 1.97
LCL: 1.842
LCL Mfg. Corrected: 1.842
Prediction Interval (y): 1.906 +/- 0.338
One-sample Mfg. t-test: t-statistic Mfg.=-2.989, p-value=0.006049566335428046
             Reject Mfg. Ho (ymean = u): True
################################################
```

========== Vinyl Chloride AreaRAE (ER) Statistics ==========

Date: 2023-05-05
Start: 17:01:56
Stop: 19:04:36

NOTE: VALUES WHICH HAVE THE ABREVIATION "MFG." HAVE THE MANUFACTURER CORRECTION FACTOR APPLIED TO THE VALUE.

########## Regression Statistics ##########
n: 51
Mean Percent Error (Mfg.): -27.345
Mean Percent Error (Assessment): -13.782
% Relative Standard Deviation (x): 130.734
% Relative Standard Deviation (y): 136.269
Standard Deviation (x): 3.658
Standard Deviation (y): 2.207
Variance (x): 13.378
Variance (y): 4.871
Covariance (xy): 8.122
Alpha: 0.05
df: (n - 2) = 49
t-value: 2.01
Correlation Coefficient (R): 0.986
R^2: 0.973
MSE (yh): 0.132
Slope: 0.595
Slope Standard Error: 0.014
Slope p-value: 4.470071816657833e-40 (Ho: slope = 0)
y-Intercept: -0.046
y-Intercept Standard Error: 0.065
Regression Equation: y = 0.595(x) - 0.046
Confidence Interval (Slope): 0.595 +/- 0.028
UCL (Slope): 0.623
LCL (Slope): 0.567
Honeywell Correction Factor: 2
Isobutylene Calibration Slope: 0.996
Assessment Correction Factor: 1.673
##

```
########## Target 0.0 ppm Statistics ##########
n: 15
Min (y): 0.0
Max (y): 0.0
Mean (y): 0.0
Mean Corrected Mfg. (y): 0.0
Median (y): 0.0
Sample Standard Deviation (y): 0.0
Variance (y): 0.0
Mean Percent Error Mfg. (y): nan
% Relative Standard Deviation (y): None
MSE: 0.0
Alpha: 0.05
df: (n - 2) = 13
t-value: 2.16
Confidence Interval (y): 0.0 +/- 0.0
Confidence Interval Corrected Mfg. (y): 0.0 +/- 0.0
UCL: 0.0
UCL Mfg. Corrected: 0.0
LCL: 0.0
LCL Mfg. Corrected: 0.0
Prediction Interval (y): 0.0 +/- 0.0
One-sample Mfg. t-test: t-statistic Mfg.=nan, p-value=nan
              Reject Mfg. Ho (ymean = u): False
################################################

########## Target 0.2 ppm Statistics ##########
n: 9
Min (y): 0.0
Max (y): 0.2
Mean (y): 0.078
Mean Corrected Mfg. (y): 0.156
Median (y): 0.1
Sample Standard Deviation (y): 0.063
Variance (y): 0.004
Mean Percent Error Mfg. (y): -22.222
% Relative Standard Deviation (y): 80.812
MSE: 0.018
Alpha: 0.05
df: (n - 2) = 7
t-value: 2.365
Confidence Interval (y): 0.078 +/- 0.05
Confidence Interval Corrected Mfg. (y): 0.156 +/- 0.099
UCL: 0.128
UCL Mfg. Corrected: 0.255
LCL: 0.028
LCL Mfg. Corrected: 0.057
Prediction Interval (y): 0.078 +/- 0.157
One-sample Mfg. t-test: t-statistic Mfg.=-1.0, p-value=0.34659350708733416
              Reject Mfg. Ho (ymean = u): False
################################################
```

```
########## Target 0.981 ppm Statistics ##########
n: 9
Min (y): 0.4
Max (y): 0.6
Mean (y): 0.5
Mean Corrected Mfg. (y): 1.0
Median (y): 0.5
Sample Standard Deviation (y): 0.082
Variance (y): 0.007
Mean Percent Error Mfg. (y): 1.937
% Relative Standard Deviation (y): 16.33
MSE: 0.027
Alpha: 0.05
df: (n - 2) = 7
t-value: 2.365
Confidence Interval (y): 0.5 +/- 0.064
Confidence Interval Corrected Mfg. (y): 1.0 +/- 0.129
UCL: 0.564
UCL Mfg. Corrected: 1.129
LCL: 0.436
LCL Mfg. Corrected: 0.871
Prediction Interval (y): 0.5 +/- 0.204
One-sample Mfg. t-test: t-statistic Mfg.=0.329, p-value=0.7505379264969623
             Reject Mfg. Ho (ymean = u): False
##################################################

########## Target 4.937 ppm Statistics ##########
n: 9
Min (y): 2.3
Max (y): 3.4
Mean (y): 2.8
Mean Corrected Mfg. (y): 5.6
Median (y): 2.8
Sample Standard Deviation (y): 0.411
Variance (y): 0.169
Mean Percent Error Mfg. (y): 13.429
% Relative Standard Deviation (y): 14.677
MSE: 1.115
Alpha: 0.05
df: (n - 2) = 7
t-value: 2.365
Confidence Interval (y): 2.8 +/- 0.324
Confidence Interval Corrected Mfg. (y): 5.6 +/- 0.648
UCL: 3.124
UCL Mfg. Corrected: 6.248
LCL: 2.476
LCL Mfg. Corrected: 4.952
Prediction Interval (y): 2.8 +/- 1.024
One-sample Mfg. t-test: t-statistic Mfg.=2.282, p-value=0.051946351955730295
             Reject Mfg. Ho (ymean = u): False
##################################################
```

```
########## Target 9.736 ppm Statistics ##########
n: 9
Min (y): 5.0
Max (y): 6.9
Mean (y): 5.8
Mean Corrected Mfg. (y): 11.6
Median (y): 5.6
Sample Standard Deviation (y): 0.742
Variance (y): 0.551
Mean Percent Error Mfg. (y): 19.145
% Relative Standard Deviation (y): 12.799
MSE: 5.679
Alpha: 0.05
df: (n - 2) = 7
t-value: 2.365
Confidence Interval (y): 5.8 +/- 0.585
Confidence Interval Corrected Mfg. (y): 11.6 +/- 1.17
UCL: 6.385
UCL Mfg. Corrected: 12.77
LCL: 5.215
LCL Mfg. Corrected: 10.43
Prediction Interval (y): 5.8 +/- 1.85
One-sample Mfg. t-test: t-statistic Mfg.=3.551, p-value=0.007499328218612196
             Reject Mfg. Ho (ymean = u): True
##################################################
```

========== Vinyl Chloride AreaRAE Pro (PPB) Statistics ==========

Date: 2023-05-03
Start: 18:08:35
Stop: 19:18:30

NOTE: VALUES WHICH HAVE THE ABREVIATION "MFG." HAVE THE MANUFACTURER CORRECTION FACTOR APPLIED TO THE VALUE.

########## Regression Statistics ##########
n: 57
Mean Percent Error (Mfg.): -71.574
Mean Percent Error (Assessment): 49.898
% Relative Standard Deviation (x): 141.736
% Relative Standard Deviation (y): 136.867
Standard Deviation (x): 3.559
Standard Deviation (y): 2.335
Variance (x): 12.668
Variance (y): 5.454
Covariance (xy): 8.455
Alpha: 0.05
df: (n - 2) = 55
t-value: 2.004
Correlation Coefficient (R): 0.999
R^2: 0.999
MSE (yh): 0.007
Slope: 0.656
Slope Standard Error: 0.003
Slope p-value: 1.9646995315049924e-81 (Ho: slope = 0)
y-Intercept: 0.06
y-Intercept Standard Error: 0.014
Regression Equation: y = 0.656(x) + 0.06
Confidence Interval (Slope): 0.656 +/- 0.006
UCL (Slope): 0.662
LCL (Slope): 0.65
Honeywell Correction Factor: 2
Isobutylene Calibration Slope: 0.981
Assessment Correction Factor: 1.497
##

```
########## Target 0.0 ppm Statistics ##########
n: 12
Min (y): 0.02
Max (y): 0.19
Mean (y): 0.11
Mean Corrected Mfg. (y): 0.22
Median (y): 0.115
Sample Standard Deviation (y): 0.058
Variance (y): 0.003
Mean Percent Error Mfg. (y): nan
% Relative Standard Deviation (y): 52.879
MSE: 0.062
Alpha: 0.05
df: (n - 2) = 10
t-value: 2.228
Confidence Interval (y): 0.11 +/- 0.037
Confidence Interval Corrected Mfg. (y): 0.22 +/- 0.075
UCL: 0.147
UCL Mfg. Corrected: 0.295
LCL: 0.073
LCL Mfg. Corrected: 0.145
Prediction Interval (y): 0.11 +/- 0.135
One-sample Mfg. t-test: t-statistic Mfg.=6.272, p-value=6.069023706945485e-05
             Reject Mfg. Ho (ymean = u): True
################################################

########## Target 0.05 ppm Statistics ##########
n: 9
Min (y): 0.06
Max (y): 0.18
Mean (y): 0.111
Mean Corrected Mfg. (y): 0.222
Median (y): 0.12
Sample Standard Deviation (y): 0.041
Variance (y): 0.002
Mean Percent Error Mfg. (y): 344.444
% Relative Standard Deviation (y): 37.094
MSE: 0.036
Alpha: 0.05
df: (n - 2) = 7
t-value: 2.365
Confidence Interval (y): 0.111 +/- 0.032
Confidence Interval Corrected Mfg. (y): 0.222 +/- 0.065
UCL: 0.143
UCL Mfg. Corrected: 0.287
LCL: 0.079
LCL Mfg. Corrected: 0.157
Prediction Interval (y): 0.111 +/- 0.103
One-sample Mfg. t-test: t-statistic Mfg.=5.909, p-value=0.0003579676151293206
             Reject Mfg. Ho (ymean = u): True
################################################
```

```
########## Target 0.2 ppm Statistics ##########
n: 9
Min (y): 0.11
Max (y): 0.22
Mean (y): 0.159
Mean Corrected Mfg. (y): 0.318
Median (y): 0.16
Sample Standard Deviation (y): 0.037
Variance (y): 0.001
Mean Percent Error Mfg. (y): 58.889
% Relative Standard Deviation (y): 23.066
MSE: 0.019
Alpha: 0.05
df: (n - 2) = 7
t-value: 2.365
Confidence Interval (y): 0.159 +/- 0.029
Confidence Interval Corrected Mfg. (y): 0.318 +/- 0.058
UCL: 0.188
UCL Mfg. Corrected: 0.376
LCL: 0.13
LCL Mfg. Corrected: 0.26
Prediction Interval (y): 0.159 +/- 0.091
One-sample Mfg. t-test: t-statistic Mfg.=4.545, p-value=0.0018874542617996473
             Reject Mfg. Ho (ymean = u): True
################################################

########## Target 0.981 ppm Statistics ##########
n: 9
Min (y): 0.57
Max (y): 0.77
Mean (y): 0.651
Mean Corrected Mfg. (y): 1.302
Median (y): 0.66
Sample Standard Deviation (y): 0.066
Variance (y): 0.004
Mean Percent Error Mfg. (y): 32.744
% Relative Standard Deviation (y): 10.147
MSE: 0.121
Alpha: 0.05
df: (n - 2) = 7
t-value: 2.365
Confidence Interval (y): 0.651 +/- 0.052
Confidence Interval Corrected Mfg. (y): 1.302 +/- 0.104
UCL: 0.703
UCL Mfg. Corrected: 1.406
LCL: 0.599
LCL Mfg. Corrected: 1.198
Prediction Interval (y): 0.651 +/- 0.165
One-sample Mfg. t-test: t-statistic Mfg.=6.876, p-value=0.00012764361571770567
             Reject Mfg. Ho (ymean = u): True
################################################
```

```
########## Target 4.937 ppm Statistics ##########
n: 9
Min (y): 3.17
Max (y): 3.41
Mean (y): 3.281
Mean Corrected Mfg. (y): 6.562
Median (y): 3.28
Sample Standard Deviation (y): 0.083
Variance (y): 0.007
Mean Percent Error Mfg. (y): 32.919
% Relative Standard Deviation (y): 2.519
MSE: 2.669
Alpha: 0.05
df: (n - 2) = 7
t-value: 2.365
Confidence Interval (y): 3.281 +/- 0.065
Confidence Interval Corrected Mfg. (y): 6.562 +/- 0.13
UCL: 3.346
UCL Mfg. Corrected: 6.692
LCL: 3.216
LCL Mfg. Corrected: 6.432
Prediction Interval (y): 3.281 +/- 0.206
One-sample Mfg. t-test: t-statistic Mfg.=27.807, p-value=3.019382514127103e-09
             Reject Mfg. Ho (ymean = u): True
##################################################

########## Target 9.736 ppm Statistics ##########
n: 9
Min (y): 6.32
Max (y): 6.68
Mean (y): 6.458
Mean Corrected Mfg. (y): 12.916
Median (y): 6.41
Sample Standard Deviation (y): 0.13
Variance (y): 0.017
Mean Percent Error Mfg. (y): 32.658
% Relative Standard Deviation (y): 2.013
MSE: 10.177
Alpha: 0.05
df: (n - 2) = 7
t-value: 2.365
Confidence Interval (y): 6.458 +/- 0.102
Confidence Interval Corrected Mfg. (y): 12.916 +/- 0.205
UCL: 6.56
UCL Mfg. Corrected: 13.121
LCL: 6.356
LCL Mfg. Corrected: 12.711
Prediction Interval (y): 6.458 +/- 0.324
One-sample Mfg. t-test: t-statistic Mfg.=34.583, p-value=5.344707034339135e-10
             Reject Mfg. Ho (ymean = u): True
##################################################
```

========== Vinyl Chloride MultiRAE Pro (ER) Statistics ==========

Date: 2023-05-05
Start: 08:19:56
Stop: 09:19:43

NOTE: VALUES WHICH HAVE THE ABREVIATION "MFG." HAVE THE MANUFACTURER CORRECTION FACTOR APPLIED TO THE VALUE.

########## Regression Statistics ##########
n: 51
Mean Percent Error (Mfg.): -14.95
Mean Percent Error (Assessment): -12.491
% Relative Standard Deviation (x): 130.734
% Relative Standard Deviation (y): 134.829
Standard Deviation (x): 3.658
Standard Deviation (y): 2.361
Variance (x): 13.378
Variance (y): 5.573
Covariance (xy): 8.802
Alpha: 0.05
df: (n - 2) = 49
t-value: 2.01
Correlation Coefficient (R): 0.999
R^2: 0.999
MSE (yh): 0.008
Slope: 0.645
Slope Standard Error: 0.003
Slope p-value: 8.005448958897224e-72 (Ho: slope = 0)
y-Intercept: -0.054
y-Intercept Standard Error: 0.016
Regression Equation: y = 0.645(x) - 0.054
Confidence Interval (Slope): 0.645 +/- 0.007
UCL (Slope): 0.652
LCL (Slope): 0.638
Honeywell Correction Factor: 2
Isobutylene Calibration Slope: 0.997
Assessment Correction Factor: 1.546
##

```
########## Target 0.0 ppm Statistics ##########
n: 15
Min (y): 0.0
Max (y): 0.1
Mean (y): 0.013
Mean Corrected Mfg. (y): 0.027
Median (y): 0.0
Sample Standard Deviation (y): 0.034
Variance (y): 0.001
Mean Percent Error Mfg. (y): nan
% Relative Standard Deviation (y): 254.951
MSE: 0.005
Alpha: 0.05
df: (n - 2) = 13
t-value: 2.16
Confidence Interval (y): 0.013 +/- 0.019
Confidence Interval Corrected Mfg. (y): 0.027 +/- 0.038
UCL: 0.032
UCL Mfg. Corrected: 0.065
LCL: -0.006
LCL Mfg. Corrected: -0.011
Prediction Interval (y): 0.013 +/- 0.076
One-sample Mfg. t-test: t-statistic Mfg.=1.468, p-value=0.16431789846959996
             Reject Mfg. Ho (ymean = u): False
################################################

########## Target 0.2 ppm Statistics ##########
n: 9
Min (y): 0.1
Max (y): 0.1
Mean (y): 0.1
Mean Corrected Mfg. (y): 0.2
Median (y): 0.1
Sample Standard Deviation (y): 0.0
Variance (y): 0.0
Mean Percent Error Mfg. (y): 0.0
% Relative Standard Deviation (y): 0.0
MSE: 0.0
Alpha: 0.05
df: (n - 2) = 7
t-value: 2.365
Confidence Interval (y): 0.1 +/- 0.0
Confidence Interval Corrected Mfg. (y): 0.2 +/- 0.0
UCL: 0.1
UCL Mfg. Corrected: 0.2
LCL: 0.1
LCL Mfg. Corrected: 0.2
Prediction Interval (y): 0.1 +/- 0.0
One-sample Mfg. t-test: t-statistic Mfg.=nan, p-value=nan
             Reject Mfg. Ho (ymean = u): False
################################################
```

```
########## Target 0.981 ppm Statistics ##########
n: 9
Min (y): 0.5
Max (y): 0.5
Mean (y): 0.5
Mean Corrected Mfg. (y): 1.0
Median (y): 0.5
Sample Standard Deviation (y): 0.0
Variance (y): 0.0
Mean Percent Error Mfg. (y): 1.937
% Relative Standard Deviation (y): 0.0
MSE: 0.0
Alpha: 0.05
df: (n - 2) = 7
t-value: 2.365
Confidence Interval (y): 0.5 +/- 0.0
Confidence Interval Corrected Mfg. (y): 1.0 +/- 0.0
UCL: 0.5
UCL Mfg. Corrected: 1.0
LCL: 0.5
LCL Mfg. Corrected: 1.0
Prediction Interval (y): 0.5 +/- 0.0
One-sample Mfg. t-test: t-statistic Mfg.=inf, p-value=0.0
             Reject Mfg. Ho (ymean = u): True
##################################################

########## Target 4.937 ppm Statistics ##########
n: 9
Min (y): 3.0
Max (y): 3.0
Mean (y): 3.0
Mean Corrected Mfg. (y): 6.0
Median (y): 3.0
Sample Standard Deviation (y): 0.0
Variance (y): 0.0
Mean Percent Error Mfg. (y): 21.531
% Relative Standard Deviation (y): 0.0
MSE: 1.13
Alpha: 0.05
df: (n - 2) = 7
t-value: 2.365
Confidence Interval (y): 3.0 +/- 0.0
Confidence Interval Corrected Mfg. (y): 6.0 +/- 0.0
UCL: 3.0
UCL Mfg. Corrected: 6.0
LCL: 3.0
LCL Mfg. Corrected: 6.0
Prediction Interval (y): 3.0 +/- 0.0
One-sample Mfg. t-test: t-statistic Mfg.=inf, p-value=0.0
             Reject Mfg. Ho (ymean = u): True
##################################################
```

```
########## Target 9.736 ppm Statistics ##########
n: 9
Min (y): 6.2
Max (y): 6.4
Mean (y): 6.3
Mean Corrected Mfg. (y): 12.6
Median (y): 6.3
Sample Standard Deviation (y): 0.067
Variance (y): 0.004
Mean Percent Error Mfg. (y): 29.417
% Relative Standard Deviation (y): 1.058
MSE: 8.22
Alpha: 0.05
df: (n - 2) = 7
t-value: 2.365
Confidence Interval (y): 6.3 +/- 0.053
Confidence Interval Corrected Mfg. (y): 12.6 +/- 0.105
UCL: 6.353
UCL Mfg. Corrected: 12.705
LCL: 6.247
LCL Mfg. Corrected: 12.495
Prediction Interval (y): 6.3 +/- 0.166
One-sample Mfg. t-test: t-statistic Mfg.=60.755, p-value=5.986856936116672e-12
             Reject Mfg. Ho (ymean = u): True
##################################################
```

========== Vinyl Chloride MultiRAE Pro (PPB) Statistics ==========

Date: 2023-05-03
Start: 10:56:00
Stop: 12:11:37

NOTE: VALUES WHICH HAVE THE ABREVIATION "MFG." HAVE THE MANUFACTURER CORRECTION FACTOR APPLIED TO THE VALUE.

########## Regression Statistics ##########
n: 60
Mean Percent Error (Mfg.): -49.595
Mean Percent Error (Assessment): -27.656
% Relative Standard Deviation (x): 147.217
% Relative Standard Deviation (y): 151.453
Standard Deviation (x): 3.512
Standard Deviation (y): 2.219
Variance (x): 12.334
Variance (y): 4.922
Covariance (xy): 7.91
Alpha: 0.05
df: (n - 2) = 58
t-value: 2.002
Correlation Coefficient (R): 0.998
R^2: 0.997
MSE (yh): 0.017
Slope: 0.631
Slope Standard Error: 0.005
Slope p-value: 2.202305450580531e-73 (Ho: slope = 0)
y-Intercept: -0.04
y-Intercept Standard Error: 0.02
Regression Equation: y = 0.631(x) - 0.04
Confidence Interval (Slope): 0.631 +/- 0.01
UCL (Slope): 0.641
LCL (Slope): 0.621
Honeywell Correction Factor: 2
Isobutylene Calibration Slope: 0.963
Assessment Correction Factor: 1.526
##

```
########## Target 0.0 ppm Statistics ##########
n: 15
Min (y): 0.0
Max (y): 0.05
Mean (y): 0.009
Mean Corrected Mfg. (y): 0.017
Median (y): 0.0
Sample Standard Deviation (y): 0.018
Variance (y): 0.0
Mean Percent Error Mfg. (y): nan
% Relative Standard Deviation (y): 205.832
MSE: 0.002
Alpha: 0.05
df: (n - 2) = 13
t-value: 2.16
Confidence Interval (y): 0.009 +/- 0.01
Confidence Interval Corrected Mfg. (y): 0.017 +/- 0.02
UCL: 0.019
UCL Mfg. Corrected: 0.037
LCL: -0.001
LCL Mfg. Corrected: -0.003
Prediction Interval (y): 0.009 +/- 0.04
One-sample Mfg. t-test: t-statistic Mfg.=1.818, p-value=0.09054983334068686
             Reject Mfg. Ho (ymean = u): False
################################################

########## Target 0.05 ppm Statistics ##########
n: 9
Min (y): 0.0
Max (y): 0.07
Mean (y): 0.02
Mean Corrected Mfg. (y): 0.04
Median (y): 0.01
Sample Standard Deviation (y): 0.025
Variance (y): 0.001
Mean Percent Error Mfg. (y): -20.0
% Relative Standard Deviation (y): 124.722
MSE: 0.003
Alpha: 0.05
df: (n - 2) = 7
t-value: 2.365
Confidence Interval (y): 0.02 +/- 0.02
Confidence Interval Corrected Mfg. (y): 0.04 +/- 0.039
UCL: 0.04
UCL Mfg. Corrected: 0.079
LCL: 0.0
LCL Mfg. Corrected: 0.001
Prediction Interval (y): 0.02 +/- 0.062
One-sample Mfg. t-test: t-statistic Mfg.=-0.567, p-value=0.586301492244869
             Reject Mfg. Ho (ymean = u): False
################################################
```

```
########## Target 0.2 ppm Statistics ##########
n: 9
Min (y): 0.03
Max (y): 0.1
Mean (y): 0.051
Mean Corrected Mfg. (y): 0.102
Median (y): 0.05
Sample Standard Deviation (y): 0.022
Variance (y): 0.0
Mean Percent Error Mfg. (y): -48.889
% Relative Standard Deviation (y): 42.711
MSE: 0.011
Alpha: 0.05
df: (n - 2) = 7
t-value: 2.365
Confidence Interval (y): 0.051 +/- 0.017
Confidence Interval Corrected Mfg. (y): 0.102 +/- 0.034
UCL: 0.068
UCL Mfg. Corrected: 0.136
LCL: 0.034
LCL Mfg. Corrected: 0.068
Prediction Interval (y): 0.051 +/- 0.054
One-sample Mfg. t-test: t-statistic Mfg.=-6.334, p-value=0.00022433742433375622
             Reject Mfg. Ho (ymean = u): True
################################################

########## Target 0.981 ppm Statistics ##########
n: 9
Min (y): 0.39
Max (y): 0.5
Mean (y): 0.439
Mean Corrected Mfg. (y): 0.878
Median (y): 0.45
Sample Standard Deviation (y): 0.039
Variance (y): 0.002
Mean Percent Error Mfg. (y): -10.522
% Relative Standard Deviation (y): 8.951
MSE: 0.017
Alpha: 0.05
df: (n - 2) = 7
t-value: 2.365
Confidence Interval (y): 0.439 +/- 0.031
Confidence Interval Corrected Mfg. (y): 0.878 +/- 0.062
UCL: 0.47
UCL Mfg. Corrected: 0.94
LCL: 0.408
LCL Mfg. Corrected: 0.816
Prediction Interval (y): 0.439 +/- 0.098
One-sample Mfg. t-test: t-statistic Mfg.=-3.716, p-value=0.005905222648798084
             Reject Mfg. Ho (ymean = u): True
################################################
```

```
########## Target 4.937 ppm Statistics ##########
n: 9
Min (y): 2.88
Max (y): 3.4
Mean (y): 3.18
Mean Corrected Mfg. (y): 6.36
Median (y): 3.25
Sample Standard Deviation (y): 0.201
Variance (y): 0.04
Mean Percent Error Mfg. (y): 28.823
% Relative Standard Deviation (y): 6.324
MSE: 2.187
Alpha: 0.05
df: (n - 2) = 7
t-value: 2.365
Confidence Interval (y): 3.18 +/- 0.159
Confidence Interval Corrected Mfg. (y): 6.36 +/- 0.317
UCL: 3.339
UCL Mfg. Corrected: 6.677
LCL: 3.021
LCL Mfg. Corrected: 6.043
Prediction Interval (y): 3.18 +/- 0.501
One-sample Mfg. t-test: t-statistic Mfg.=10.007, p-value=8.445901066299821e-06
             Reject Mfg. Ho (ymean = u): True
##################################################

########## Target 9.736 ppm Statistics ##########
n: 9
Min (y): 5.79
Max (y): 6.32
Mean (y): 6.061
Mean Corrected Mfg. (y): 12.122
Median (y): 6.02
Sample Standard Deviation (y): 0.17
Variance (y): 0.029
Mean Percent Error Mfg. (y): 24.509
% Relative Standard Deviation (y): 2.799
MSE: 5.809
Alpha: 0.05
df: (n - 2) = 7
t-value: 2.365
Confidence Interval (y): 6.061 +/- 0.134
Confidence Interval Corrected Mfg. (y): 12.122 +/- 0.267
UCL: 6.195
UCL Mfg. Corrected: 12.389
LCL: 5.927
LCL Mfg. Corrected: 11.855
Prediction Interval (y): 6.061 +/- 0.423
One-sample Mfg. t-test: t-statistic Mfg.=19.889, p-value=4.255283662939443e-08
             Reject Mfg. Ho (ymean = u): True
##################################################
```

============== Vinyl Chloride Post BA AreaRAE (ER) Statistics ==============

Date: 2023-05-06
Start: 13:17:42
Stop: 14:28:09

NOTE: VALUES WHICH HAVE THE ABREVIATION "MFG." HAVE THE MANUFACTURER
CORRECTION FACTOR APPLIED TO THE VALUE.

########## Regression Statistics ##########
n: 51
Mean Percent Error (Mfg.): -1.693
Mean Percent Error (Assessment): 11.76
% Relative Standard Deviation (x): 130.734
% Relative Standard Deviation (y): 130.275
Standard Deviation (x): 3.658
Standard Deviation (y): 2.146
Variance (x): 13.378
Variance (y): 4.604
Covariance (xy): 7.919
Alpha: 0.05
df: (n - 2) = 49
t-value: 2.01
Correlation Coefficient (R): 0.989
R^2: 0.979
MSE (yh): 0.098
Slope: 0.58
Slope Standard Error: 0.012
Slope p-value: 1.3800488423312624e-42 (Ho: slope = 0)
y-Intercept: 0.023
y-Intercept Standard Error: 0.056
Regression Equation: y = 0.58(x) + 0.023
Confidence Interval (Slope): 0.58 +/- 0.025
UCL (Slope): 0.605
LCL (Slope): 0.555
Honeywell Correction Factor: 2
Isobutylene Calibration Slope: 0.996
Assessment Correction Factor: 1.716
##

```
########## Target 0.0 ppm Statistics ##########
n: 15
Min (y): 0.0
Max (y): 0.1
Mean (y): 0.04
Mean Corrected Mfg. (y): 0.08
Median (y): 0.0
Sample Standard Deviation (y): 0.049
Variance (y): 0.002
Mean Percent Error Mfg. (y): nan
% Relative Standard Deviation (y): 122.474
MSE: 0.016
Alpha: 0.05
df: (n - 2) = 13
t-value: 2.16
Confidence Interval (y): 0.04 +/- 0.027
Confidence Interval Corrected Mfg. (y): 0.08 +/- 0.055
UCL: 0.067
UCL Mfg. Corrected: 0.135
LCL: 0.013
LCL Mfg. Corrected: 0.025
Prediction Interval (y): 0.04 +/- 0.109
One-sample Mfg. t-test: t-statistic Mfg.=3.055, p-value=0.008563538081895498
             Reject Mfg. Ho (ymean = u): True
################################################

########## Target 0.2 ppm Statistics ##########
n: 9
Min (y): 0.1
Max (y): 0.2
Mean (y): 0.178
Mean Corrected Mfg. (y): 0.356
Median (y): 0.2
Sample Standard Deviation (y): 0.042
Variance (y): 0.002
Mean Percent Error Mfg. (y): 77.778
% Relative Standard Deviation (y): 23.385
MSE: 0.031
Alpha: 0.05
df: (n - 2) = 7
t-value: 2.365
Confidence Interval (y): 0.178 +/- 0.033
Confidence Interval Corrected Mfg. (y): 0.356 +/- 0.066
UCL: 0.211
UCL Mfg. Corrected: 0.422
LCL: 0.145
LCL Mfg. Corrected: 0.29
Prediction Interval (y): 0.178 +/- 0.104
One-sample Mfg. t-test: t-statistic Mfg.=5.292, p-value=0.0007359017195464896
             Reject Mfg. Ho (ymean = u): True
################################################
```

```
########## Target 0.981 ppm Statistics ##########
n: 9
Min (y): 0.4
Max (y): 0.6
Mean (y): 0.544
Mean Corrected Mfg. (y): 1.089
Median (y): 0.6
Sample Standard Deviation (y): 0.083
Variance (y): 0.007
Mean Percent Error Mfg. (y): 10.998
% Relative Standard Deviation (y): 15.272
MSE: 0.039
Alpha: 0.05
df: (n - 2) = 7
t-value: 2.365
Confidence Interval (y): 0.544 +/- 0.066
Confidence Interval Corrected Mfg. (y): 1.089 +/- 0.131
UCL: 0.61
UCL Mfg. Corrected: 1.22
LCL: 0.478
LCL Mfg. Corrected: 0.958
Prediction Interval (y): 0.544 +/- 0.207
One-sample Mfg. t-test: t-statistic Mfg.=1.835, p-value=0.10383556032791236
             Reject Mfg. Ho (ymean = u): False
##################################################

########## Target 4.937 ppm Statistics ##########
n: 9
Min (y): 2.3
Max (y): 3.3
Mean (y): 2.844
Mean Corrected Mfg. (y): 5.689
Median (y): 2.9
Sample Standard Deviation (y): 0.398
Variance (y): 0.158
Mean Percent Error Mfg. (y): 15.23
% Relative Standard Deviation (y): 13.975
MSE: 1.197
Alpha: 0.05
df: (n - 2) = 7
t-value: 2.365
Confidence Interval (y): 2.844 +/- 0.313
Confidence Interval Corrected Mfg. (y): 5.689 +/- 0.627
UCL: 3.157
UCL Mfg. Corrected: 6.316
LCL: 2.531
LCL Mfg. Corrected: 5.062
Prediction Interval (y): 2.844 +/- 0.991
One-sample Mfg. t-test: t-statistic Mfg.=2.675, p-value=0.028147988961061923
             Reject Mfg. Ho (ymean = u): True
##################################################
```

```
########## Target 9.736 ppm Statistics ##########
n: 9
Min (y): 5.0
Max (y): 6.5
Mean (y): 5.7
Mean Corrected Mfg. (y): 11.4
Median (y): 5.6
Sample Standard Deviation (y): 0.616
Variance (y): 0.38
Mean Percent Error Mfg. (y): 17.091
% Relative Standard Deviation (y): 10.815
MSE: 4.289
Alpha: 0.05
df: (n - 2) = 7
t-value: 2.365
Confidence Interval (y): 5.7 +/- 0.486
Confidence Interval Corrected Mfg. (y): 11.4 +/- 0.972
UCL: 6.186
UCL Mfg. Corrected: 12.372
LCL: 5.214
LCL Mfg. Corrected: 10.428
Prediction Interval (y): 5.7 +/- 1.537
One-sample Mfg. t-test: t-statistic Mfg.=3.817, p-value=0.005108008445355428
             Reject Mfg. Ho (ymean = u): True
##################################################
```

========== Vinyl Chloride Post BA AreaRAE Pro (PPB) Statistics ==========

Date: 2023-05-04
Start: 15:41:00
Stop: 17:03:00

NOTE: VALUES WHICH HAVE THE ABREVIATION "MFG." HAVE THE MANUFACTURER
CORRECTION FACTOR APPLIED TO THE VALUE.

########## Regression Statistics ##########
n: 60
Mean Percent Error (Mfg.): -124.793
Mean Percent Error (Assessment): -2.326
% Relative Standard Deviation (x): 147.217
% Relative Standard Deviation (y): 148.289
Standard Deviation (x): 3.512
Standard Deviation (y): 2.269
Variance (x): 12.334
Variance (y): 5.146
Covariance (xy): 8.095
Alpha: 0.05
df: (n - 2) = 58
t-value: 2.002
Correlation Coefficient (R): 0.999
R^2: 0.998
MSE (yh): 0.009
Slope: 0.645
Slope Standard Error: 0.004
Slope p-value: 1.8554846528678178e-81 (Ho: slope = 0)
y-Intercept: -0.01
y-Intercept Standard Error: 0.015
Regression Equation: y = 0.645(x) - 0.01
Confidence Interval (Slope): 0.645 +/- 0.007
UCL (Slope): 0.652
LCL (Slope): 0.638
Honeywell Correction Factor: 2
Isobutylene Calibration Slope: 0.981
Assessment Correction Factor: 1.521
##

```
########## Target 0.0 ppm Statistics ##########
n: 15
Min (y): 0.0
Max (y): 0.16
Mean (y): 0.029
Mean Corrected Mfg. (y): 0.059
Median (y): 0.0
Sample Standard Deviation (y): 0.056
Variance (y): 0.003
Mean Percent Error Mfg. (y): nan
% Relative Standard Deviation (y): 192.23
MSE: 0.016
Alpha: 0.05
df: (n - 2) = 13
t-value: 2.16
Confidence Interval (y): 0.029 +/- 0.031
Confidence Interval Corrected Mfg. (y): 0.059 +/- 0.063
UCL: 0.06
UCL Mfg. Corrected: 0.122
LCL: -0.002
LCL Mfg. Corrected: -0.004
Prediction Interval (y): 0.029 +/- 0.126
One-sample Mfg. t-test: t-statistic Mfg.=1.946, p-value=0.07195343294617258
             Reject Mfg. Ho (ymean = u): False
################################################

########## Target 0.05 ppm Statistics ##########
n: 9
Min (y): 0.0
Max (y): 0.1
Mean (y): 0.044
Mean Corrected Mfg. (y): 0.089
Median (y): 0.05
Sample Standard Deviation (y): 0.037
Variance (y): 0.001
Mean Percent Error Mfg. (y): 77.778
% Relative Standard Deviation (y): 82.916
MSE: 0.007
Alpha: 0.05
df: (n - 2) = 7
t-value: 2.365
Confidence Interval (y): 0.044 +/- 0.029
Confidence Interval Corrected Mfg. (y): 0.089 +/- 0.058
UCL: 0.073
UCL Mfg. Corrected: 0.147
LCL: 0.015
LCL Mfg. Corrected: 0.031
Prediction Interval (y): 0.044 +/- 0.092
One-sample Mfg. t-test: t-statistic Mfg.=1.492, p-value=0.17393859716506624
             Reject Mfg. Ho (ymean = u): False
################################################
```

```
########## Target 0.2 ppm Statistics ##########
n: 9
Min (y): 0.04
Max (y): 0.13
Mean (y): 0.093
Mean Corrected Mfg. (y): 0.187
Median (y): 0.1
Sample Standard Deviation (y): 0.027
Variance (y): 0.001
Mean Percent Error Mfg. (y): -6.667
% Relative Standard Deviation (y): 28.571
MSE: 0.003
Alpha: 0.05
df: (n - 2) = 7
t-value: 2.365
Confidence Interval (y): 0.093 +/- 0.021
Confidence Interval Corrected Mfg. (y): 0.187 +/- 0.042
UCL: 0.114
UCL Mfg. Corrected: 0.229
LCL: 0.072
LCL Mfg. Corrected: 0.145
Prediction Interval (y): 0.093 +/- 0.066
One-sample Mfg. t-test: t-statistic Mfg.=-0.707, p-value=0.4995758943632592
             Reject Mfg. Ho (ymean = u): False
################################################

########## Target 0.981 ppm Statistics ##########
n: 9
Min (y): 0.49
Max (y): 0.62
Mean (y): 0.558
Mean Corrected Mfg. (y): 1.116
Median (y): 0.56
Sample Standard Deviation (y): 0.04
Variance (y): 0.002
Mean Percent Error Mfg. (y): 13.716
% Relative Standard Deviation (y): 7.21
MSE: 0.025
Alpha: 0.05
df: (n - 2) = 7
t-value: 2.365
Confidence Interval (y): 0.558 +/- 0.032
Confidence Interval Corrected Mfg. (y): 1.116 +/- 0.063
UCL: 0.59
UCL Mfg. Corrected: 1.179
LCL: 0.526
LCL Mfg. Corrected: 1.053
Prediction Interval (y): 0.558 +/- 0.1
One-sample Mfg. t-test: t-statistic Mfg.=4.732, p-value=0.0014795521313597272
             Reject Mfg. Ho (ymean = u): True
################################################
```

```
########## Target 4.937 ppm Statistics ##########
n: 9
Min (y): 3.04
Max (y): 3.32
Mean (y): 3.171
Mean Corrected Mfg. (y): 6.342
Median (y): 3.16
Sample Standard Deviation (y): 0.101
Variance (y): 0.01
Mean Percent Error Mfg. (y): 28.463
% Relative Standard Deviation (y): 3.172
MSE: 2.015
Alpha: 0.05
df: (n - 2) = 7
t-value: 2.365
Confidence Interval (y): 3.171 +/- 0.079
Confidence Interval Corrected Mfg. (y): 6.342 +/- 0.159
UCL: 3.25
UCL Mfg. Corrected: 6.501
LCL: 3.092
LCL Mfg. Corrected: 6.183
Prediction Interval (y): 3.171 +/- 0.251
One-sample Mfg. t-test: t-statistic Mfg.=19.754, p-value=4.490498082617619e-08
             Reject Mfg. Ho (ymean = u): True
##################################################

########## Target 9.736 ppm Statistics ##########
n: 9
Min (y): 6.05
Max (y): 6.55
Mean (y): 6.283
Mean Corrected Mfg. (y): 12.567
Median (y): 6.25
Sample Standard Deviation (y): 0.184
Variance (y): 0.034
Mean Percent Error Mfg. (y): 29.074
% Relative Standard Deviation (y): 2.925
MSE: 8.148
Alpha: 0.05
df: (n - 2) = 7
t-value: 2.365
Confidence Interval (y): 6.283 +/- 0.145
Confidence Interval Corrected Mfg. (y): 12.567 +/- 0.29
UCL: 6.428
UCL Mfg. Corrected: 12.857
LCL: 6.138
LCL Mfg. Corrected: 12.277
Prediction Interval (y): 6.283 +/- 0.458
One-sample Mfg. t-test: t-statistic Mfg.=21.782, p-value=2.081446753995331e-08
             Reject Mfg. Ho (ymean = u): True
##################################################
```

========== Vinyl Chloride Post BA MultiRAE Pro (ER) Statistics ==========

Date: 2023-05-05
Start: 13:20:45
Stop: 14:26:08

NOTE: VALUES WHICH HAVE THE ABREVIATION "MFG." HAVE THE MANUFACTURER CORRECTION FACTOR APPLIED TO THE VALUE.

########## Regression Statistics ##########
n: 51
Mean Percent Error (Mfg.): -13.846
Mean Percent Error (Assessment): -11.39
% Relative Standard Deviation (x): 130.734
% Relative Standard Deviation (y): 135.394
Standard Deviation (x): 3.658
Standard Deviation (y): 2.44
Variance (x): 13.378
Variance (y): 5.952
Covariance (xy): 9.089
Alpha: 0.05
df: (n - 2) = 49
t-value: 2.01
Correlation Coefficient (R): 0.999
R^2: 0.997
MSE (yh): 0.017
Slope: 0.666
Slope Standard Error: 0.005
Slope p-value: 8.29589473673846e-64 (Ho: slope = 0)
y-Intercept: -0.062
y-Intercept Standard Error: 0.024
Regression Equation: y = 0.666(x) - 0.062
Confidence Interval (Slope): 0.666 +/- 0.01
UCL (Slope): 0.676
LCL (Slope): 0.656
Honeywell Correction Factor: 2
Isobutylene Calibration Slope: 0.997
Assessment Correction Factor: 1.497
##

```
########## Target 0.0 ppm Statistics ##########
n: 15
Min (y): 0.0
Max (y): 0.1
Mean (y): 0.02
Mean Corrected Mfg. (y): 0.04
Median (y): 0.0
Sample Standard Deviation (y): 0.04
Variance (y): 0.002
Mean Percent Error Mfg. (y): nan
% Relative Standard Deviation (y): 200.0
MSE: 0.008
Alpha: 0.05
df: (n - 2) = 13
t-value: 2.16
Confidence Interval (y): 0.02 +/- 0.022
Confidence Interval Corrected Mfg. (y): 0.04 +/- 0.045
UCL: 0.042
UCL Mfg. Corrected: 0.085
LCL: -0.002
LCL Mfg. Corrected: -0.005
Prediction Interval (y): 0.02 +/- 0.089
One-sample Mfg. t-test: t-statistic Mfg.=1.871, p-value=0.08241787787947831
             Reject Mfg. Ho (ymean = u): False
################################################

########## Target 0.2 ppm Statistics ##########
n: 9
Min (y): 0.1
Max (y): 0.2
Mean (y): 0.111
Mean Corrected Mfg. (y): 0.222
Median (y): 0.1
Sample Standard Deviation (y): 0.031
Variance (y): 0.001
Mean Percent Error Mfg. (y): 11.111
% Relative Standard Deviation (y): 28.284
MSE: 0.004
Alpha: 0.05
df: (n - 2) = 7
t-value: 2.365
Confidence Interval (y): 0.111 +/- 0.025
Confidence Interval Corrected Mfg. (y): 0.222 +/- 0.05
UCL: 0.136
UCL Mfg. Corrected: 0.272
LCL: 0.086
LCL Mfg. Corrected: 0.172
Prediction Interval (y): 0.111 +/- 0.078
One-sample Mfg. t-test: t-statistic Mfg.=1.0, p-value=0.3465935070873346
             Reject Mfg. Ho (ymean = u): False
################################################
```

```
########## Target 0.981 ppm Statistics ##########
n: 9
Min (y): 0.5
Max (y): 0.6
Mean (y): 0.522
Mean Corrected Mfg. (y): 1.044
Median (y): 0.5
Sample Standard Deviation (y): 0.042
Variance (y): 0.002
Mean Percent Error Mfg. (y): 6.467
% Relative Standard Deviation (y): 7.961
MSE: 0.011
Alpha: 0.05
df: (n - 2) = 7
t-value: 2.365
Confidence Interval (y): 0.522 +/- 0.033
Confidence Interval Corrected Mfg. (y): 1.044 +/- 0.066
UCL: 0.555
UCL Mfg. Corrected: 1.11
LCL: 0.489
LCL Mfg. Corrected: 0.978
Prediction Interval (y): 0.522 +/- 0.104
One-sample Mfg. t-test: t-statistic Mfg.=2.158, p-value=0.06296798443476717
             Reject Mfg. Ho (ymean = u): False
##################################################

########## Target 4.937 ppm Statistics ##########
n: 9
Min (y): 3.0
Max (y): 3.0
Mean (y): 3.0
Mean Corrected Mfg. (y): 6.0
Median (y): 3.0
Sample Standard Deviation (y): 0.0
Variance (y): 0.0
Mean Percent Error Mfg. (y): 21.531
% Relative Standard Deviation (y): 0.0
MSE: 1.13
Alpha: 0.05
df: (n - 2) = 7
t-value: 2.365
Confidence Interval (y): 3.0 +/- 0.0
Confidence Interval Corrected Mfg. (y): 6.0 +/- 0.0
UCL: 3.0
UCL Mfg. Corrected: 6.0
LCL: 3.0
LCL Mfg. Corrected: 6.0
Prediction Interval (y): 3.0 +/- 0.0
One-sample Mfg. t-test: t-statistic Mfg.=inf, p-value=0.0
             Reject Mfg. Ho (ymean = u): True
##################################################
```

```
########## Target 9.736 ppm Statistics ##########
n: 9
Min (y): 6.4
Max (y): 6.7
Mean (y): 6.544
Mean Corrected Mfg. (y): 13.089
Median (y): 6.6
Sample Standard Deviation (y): 0.096
Variance (y): 0.009
Mean Percent Error Mfg. (y): 34.438
% Relative Standard Deviation (y): 1.46
MSE: 11.278
Alpha: 0.05
df: (n - 2) = 7
t-value: 2.365
Confidence Interval (y): 6.544 +/- 0.075
Confidence Interval Corrected Mfg. (y): 13.089 +/- 0.151
UCL: 6.619
UCL Mfg. Corrected: 13.24
LCL: 6.469
LCL Mfg. Corrected: 12.938
Prediction Interval (y): 6.544 +/- 0.238
One-sample Mfg. t-test: t-statistic Mfg.=49.609, p-value=3.017570431168294e-11
             Reject Mfg. Ho (ymean = u): True
##################################################
```

========== Vinyl Chloride Post BA MultiRAE Pro (PPB) Statistics ==========

Date: 2023-05-03
Start: 10:02:35
Stop: 11:31:26

NOTE: VALUES WHICH HAVE THE ABREVIATION "MFG." HAVE THE MANUFACTURER CORRECTION FACTOR APPLIED TO THE VALUE.

########## Regression Statistics ##########
n: 57
Mean Percent Error (Mfg.): -12.57
Mean Percent Error (Assessment): 7.987
% Relative Standard Deviation (x): 141.736
% Relative Standard Deviation (y): 143.711
Standard Deviation (x): 3.559
Standard Deviation (y): 2.242
Variance (x): 12.668
Variance (y): 5.027
Covariance (xy): 8.116
Alpha: 0.05
df: (n - 2) = 55
t-value: 2.004
Correlation Coefficient (R): 0.999
R^2: 0.998
MSE (yh): 0.008
Slope: 0.629
Slope Standard Error: 0.003
Slope p-value: 5.4227815974032645e-78 (Ho: slope = 0)
y-Intercept: -0.02
y-Intercept Standard Error: 0.015
Regression Equation: y = 0.629(x) - 0.02
Confidence Interval (Slope): 0.629 +/- 0.007
UCL (Slope): 0.636
LCL (Slope): 0.622
Honeywell Correction Factor: 2
Isobutylene Calibration Slope: 0.963
Assessment Correction Factor: 1.529
##

```
########## Target 0.0 ppm Statistics ##########
n: 12
Min (y): 0.0
Max (y): 0.08
Mean (y): 0.027
Mean Corrected Mfg. (y): 0.053
Median (y): 0.02
Sample Standard Deviation (y): 0.027
Variance (y): 0.001
Mean Percent Error Mfg. (y): nan
% Relative Standard Deviation (y): 100.778
MSE: 0.006
Alpha: 0.05
df: (n - 2) = 10
t-value: 2.228
Confidence Interval (y): 0.027 +/- 0.017
Confidence Interval Corrected Mfg. (y): 0.053 +/- 0.035
UCL: 0.044
UCL Mfg. Corrected: 0.088
LCL: 0.01
LCL Mfg. Corrected: 0.018
Prediction Interval (y): 0.027 +/- 0.062
One-sample Mfg. t-test: t-statistic Mfg.=3.291, p-value=0.007191777748565899
             Reject Mfg. Ho (ymean = u): True
################################################

########## Target 0.05 ppm Statistics ##########
n: 9
Min (y): 0.02
Max (y): 0.13
Mean (y): 0.064
Mean Corrected Mfg. (y): 0.129
Median (y): 0.05
Sample Standard Deviation (y): 0.034
Variance (y): 0.001
Mean Percent Error Mfg. (y): 157.778
% Relative Standard Deviation (y): 52.805
MSE: 0.011
Alpha: 0.05
df: (n - 2) = 7
t-value: 2.365
Confidence Interval (y): 0.064 +/- 0.027
Confidence Interval Corrected Mfg. (y): 0.129 +/- 0.054
UCL: 0.091
UCL Mfg. Corrected: 0.183
LCL: 0.037
LCL Mfg. Corrected: 0.075
Prediction Interval (y): 0.064 +/- 0.085
One-sample Mfg. t-test: t-statistic Mfg.=3.278, p-value=0.011213315103394168
             Reject Mfg. Ho (ymean = u): True
################################################
```

```
########## Target 0.2 ppm Statistics ##########
n: 9
Min (y): 0.05
Max (y): 0.18
Mean (y): 0.097
Mean Corrected Mfg. (y): 0.193
Median (y): 0.1
Sample Standard Deviation (y): 0.037
Variance (y): 0.001
Mean Percent Error Mfg. (y): -3.333
% Relative Standard Deviation (y): 38.087
MSE: 0.005
Alpha: 0.05
df: (n - 2) = 7
t-value: 2.365
Confidence Interval (y): 0.097 +/- 0.029
Confidence Interval Corrected Mfg. (y): 0.193 +/- 0.058
UCL: 0.126
UCL Mfg. Corrected: 0.251
LCL: 0.068
LCL Mfg. Corrected: 0.135
Prediction Interval (y): 0.097 +/- 0.092
One-sample Mfg. t-test: t-statistic Mfg.=-0.256, p-value=0.8043555393479526
             Reject Mfg. Ho (ymean = u): False
################################################

########## Target 0.981 ppm Statistics ##########
n: 9
Min (y): 0.45
Max (y): 0.56
Mean (y): 0.501
Mean Corrected Mfg. (y): 1.002
Median (y): 0.51
Sample Standard Deviation (y): 0.039
Variance (y): 0.002
Mean Percent Error Mfg. (y): 2.163
% Relative Standard Deviation (y): 7.783
MSE: 0.007
Alpha: 0.05
df: (n - 2) = 7
t-value: 2.365
Confidence Interval (y): 0.501 +/- 0.031
Confidence Interval Corrected Mfg. (y): 1.002 +/- 0.061
UCL: 0.532
UCL Mfg. Corrected: 1.063
LCL: 0.47
LCL Mfg. Corrected: 0.941
Prediction Interval (y): 0.501 +/- 0.097
One-sample Mfg. t-test: t-statistic Mfg.=0.77, p-value=0.463674483019322
             Reject Mfg. Ho (ymean = u): False
################################################
```

```
########## Target 4.937 ppm Statistics ##########
n: 9
Min (y): 2.88
Max (y): 3.16
Mean (y): 3.044
Mean Corrected Mfg. (y): 6.089
Median (y): 3.09
Sample Standard Deviation (y): 0.112
Variance (y): 0.013
Mean Percent Error Mfg. (y): 23.332
% Relative Standard Deviation (y): 3.674
MSE: 1.377
Alpha: 0.05
df: (n - 2) = 7
t-value: 2.365
Confidence Interval (y): 3.044 +/- 0.088
Confidence Interval Corrected Mfg. (y): 6.089 +/- 0.176
UCL: 3.132
UCL Mfg. Corrected: 6.265
LCL: 2.956
LCL Mfg. Corrected: 5.913
Prediction Interval (y): 3.044 +/- 0.279
One-sample Mfg. t-test: t-statistic Mfg.=14.562, p-value=4.846482742483704e-07
             Reject Mfg. Ho (ymean = u): True
##################################################

########## Target 9.736 ppm Statistics ##########
n: 9
Min (y): 5.91
Max (y): 6.38
Mean (y): 6.139
Mean Corrected Mfg. (y): 12.277
Median (y): 6.13
Sample Standard Deviation (y): 0.135
Variance (y): 0.018
Mean Percent Error Mfg. (y): 26.102
% Relative Standard Deviation (y): 2.194
MSE: 6.531
Alpha: 0.05
df: (n - 2) = 7
t-value: 2.365
Confidence Interval (y): 6.139 +/- 0.106
Confidence Interval Corrected Mfg. (y): 12.277 +/- 0.212
UCL: 6.245
UCL Mfg. Corrected: 12.489
LCL: 6.033
LCL Mfg. Corrected: 12.065
Prediction Interval (y): 6.139 +/- 0.336
One-sample Mfg. t-test: t-statistic Mfg.=26.679, p-value=4.1918050806396015e-09
             Reject Mfg. Ho (ymean = u): True
##################################################
```

========== Vinyl Chloride Post BA ppbRAE 3000 Statistics ==========

Date: 2023-05-03
Start: 16:16:05
Stop: 17:08:31

NOTE: VALUES WHICH HAVE THE ABREVIATION "MFG." HAVE THE MANUFACTURER CORRECTION FACTOR APPLIED TO THE VALUE.

########## Regression Statistics ##########
n: 57
Mean Percent Error (Mfg.): -39.517
Mean Percent Error (Assessment): -12.806
% Relative Standard Deviation (x): 141.736
% Relative Standard Deviation (y): 142.478
Standard Deviation (x): 3.559
Standard Deviation (y): 1.752
Variance (x): 12.668
Variance (y): 3.07
Covariance (xy): 6.347
Alpha: 0.05
df: (n - 2) = 55
t-value: 2.004
Correlation Coefficient (R): 1.0
R^2: 1.0
MSE (yh): 0.001
Slope: 0.492
Slope Standard Error: 0.001
Slope p-value: 1.5051188338657368e-103 (Ho: slope = 0)
y-Intercept: -0.006
y-Intercept Standard Error: 0.004
Regression Equation: y = 0.492(x) - 0.006
Confidence Interval (Slope): 0.492 +/- 0.002
UCL (Slope): 0.494
LCL (Slope): 0.49
Honeywell Correction Factor: 2
Isobutylene Calibration Slope: 0.883
Assessment Correction Factor: 1.793
##

```
########## Target 0.0 ppm Statistics ##########
n: 12
Min (y): 0.0
Max (y): 0.0
Mean (y): 0.0
Mean Corrected Mfg. (y): 0.0
Median (y): 0.0
Sample Standard Deviation (y): 0.0
Variance (y): 0.0
Mean Percent Error Mfg. (y): nan
% Relative Standard Deviation (y): None
MSE: 0.0
Alpha: 0.05
df: (n - 2) = 10
t-value: 2.228
Confidence Interval (y): 0.0 +/- 0.0
Confidence Interval Corrected Mfg. (y): 0.0 +/- 0.0
UCL: 0.0
UCL Mfg. Corrected: 0.0
LCL: 0.0
LCL Mfg. Corrected: 0.0
Prediction Interval (y): 0.0 +/- 0.0
One-sample Mfg. t-test: t-statistic Mfg.=nan, p-value=nan
             Reject Mfg. Ho (ymean = u): False
################################################

########## Target 0.05 ppm Statistics ##########
n: 9
Min (y): 0.009
Max (y): 0.05
Mean (y): 0.029
Mean Corrected Mfg. (y): 0.057
Median (y): 0.022
Sample Standard Deviation (y): 0.015
Variance (y): 0.0
Mean Percent Error Mfg. (y): 14.667
% Relative Standard Deviation (y): 52.105
MSE: 0.001
Alpha: 0.05
df: (n - 2) = 7
t-value: 2.365
Confidence Interval (y): 0.029 +/- 0.012
Confidence Interval Corrected Mfg. (y): 0.057 +/- 0.024
UCL: 0.041
UCL Mfg. Corrected: 0.081
LCL: 0.017
LCL Mfg. Corrected: 0.033
Prediction Interval (y): 0.029 +/- 0.037
One-sample Mfg. t-test: t-statistic Mfg.=0.694, p-value=0.5071435878776298
             Reject Mfg. Ho (ymean = u): False
################################################
```

```
########## Target 0.2 ppm Statistics ##########
n: 9
Min (y): 0.053
Max (y): 0.105
Mean (y): 0.081
Mean Corrected Mfg. (y): 0.162
Median (y): 0.078
Sample Standard Deviation (y): 0.018
Variance (y): 0.0
Mean Percent Error Mfg. (y): -19.0
% Relative Standard Deviation (y): 22.344
MSE: 0.003
Alpha: 0.05
df: (n - 2) = 7
t-value: 2.365
Confidence Interval (y): 0.081 +/- 0.014
Confidence Interval Corrected Mfg. (y): 0.162 +/- 0.029
UCL: 0.095
UCL Mfg. Corrected: 0.191
LCL: 0.067
LCL Mfg. Corrected: 0.133
Prediction Interval (y): 0.081 +/- 0.045
One-sample Mfg. t-test: t-statistic Mfg.=-2.969, p-value=0.017889878122328017
             Reject Mfg. Ho (ymean = u): True
################################################

########## Target 0.981 ppm Statistics ##########
n: 9
Min (y): 0.446
Max (y): 0.478
Mean (y): 0.459
Mean Corrected Mfg. (y): 0.917
Median (y): 0.455
Sample Standard Deviation (y): 0.012
Variance (y): 0.0
Mean Percent Error Mfg. (y): -6.49
% Relative Standard Deviation (y): 2.571
MSE: 0.005
Alpha: 0.05
df: (n - 2) = 7
t-value: 2.365
Confidence Interval (y): 0.459 +/- 0.009
Confidence Interval Corrected Mfg. (y): 0.917 +/- 0.019
UCL: 0.468
UCL Mfg. Corrected: 0.936
LCL: 0.45
LCL Mfg. Corrected: 0.898
Prediction Interval (y): 0.459 +/- 0.029
One-sample Mfg. t-test: t-statistic Mfg.=-7.634, p-value=6.108171913566381e-05
             Reject Mfg. Ho (ymean = u): True
################################################
```

```
########## Target 4.937 ppm Statistics ##########
n: 9
Min (y): 2.415
Max (y): 2.473
Mean (y): 2.44
Mean Corrected Mfg. (y): 4.881
Median (y): 2.441
Sample Standard Deviation (y): 0.02
Variance (y): 0.0
Mean Percent Error Mfg. (y): -1.137
% Relative Standard Deviation (y): 0.839
MSE: 0.005
Alpha: 0.05
df: (n - 2) = 7
t-value: 2.365
Confidence Interval (y): 2.44 +/- 0.016
Confidence Interval Corrected Mfg. (y): 4.881 +/- 0.032
UCL: 2.456
UCL Mfg. Corrected: 4.913
LCL: 2.424
LCL Mfg. Corrected: 4.849
Prediction Interval (y): 2.44 +/- 0.051
One-sample Mfg. t-test: t-statistic Mfg.=-3.874, p-value=0.004714795134443608
             Reject Mfg. Ho (ymean = u): True
##################################################

########## Target 9.736 ppm Statistics ##########
n: 9
Min (y): 4.718
Max (y): 4.843
Mean (y): 4.779
Mean Corrected Mfg. (y): 9.559
Median (y): 4.789
Sample Standard Deviation (y): 0.043
Variance (y): 0.002
Mean Percent Error Mfg. (y): -1.821
% Relative Standard Deviation (y): 0.89
MSE: 0.039
Alpha: 0.05
df: (n - 2) = 7
t-value: 2.365
Confidence Interval (y): 4.779 +/- 0.034
Confidence Interval Corrected Mfg. (y): 9.559 +/- 0.067
UCL: 4.813
UCL Mfg. Corrected: 9.626
LCL: 4.745
LCL Mfg. Corrected: 9.492
Prediction Interval (y): 4.779 +/- 0.106
One-sample Mfg. t-test: t-statistic Mfg.=-5.894, p-value=0.00036433473740441207
             Reject Mfg. Ho (ymean = u): True
##################################################
```

========== Vinyl Chloride ppbRAE 3000 Statistics ==========

Date: 2023-05-03
Start: 09:16:00
Stop: 17:05:00

NOTE: VALUES WHICH HAVE THE ABREVIATION "MFG." HAVE THE MANUFACTURER CORRECTION FACTOR APPLIED TO THE VALUE.

########## Regression Statistics ##########
n: 96
Mean Percent Error (Mfg.): -36.585
Mean Percent Error (Assessment): -6.58
% Relative Standard Deviation (x): 142.716
% Relative Standard Deviation (y): 145.673
Standard Deviation (x): 3.549
Standard Deviation (y): 1.68
Variance (x): 12.593
Variance (y): 2.822
Covariance (xy): 6.004
Alpha: 0.05
df: (n - 2) = 94
t-value: 1.986
Correlation Coefficient (R): 0.997
R^2: 0.993
MSE (yh): 0.019
Slope: 0.472
Slope Standard Error: 0.004
Slope p-value: 7.832055283770222e-104 (Ho: slope = 0)
y-Intercept: -0.02
y-Intercept Standard Error: 0.017
Regression Equation: y = 0.472(x) - 0.02
Confidence Interval (Slope): 0.472 +/- 0.008
UCL (Slope): 0.48
LCL (Slope): 0.464
Honeywell Correction Factor: 2
Isobutylene Calibration Slope: 0.883
Assessment Correction Factor: 1.871
##

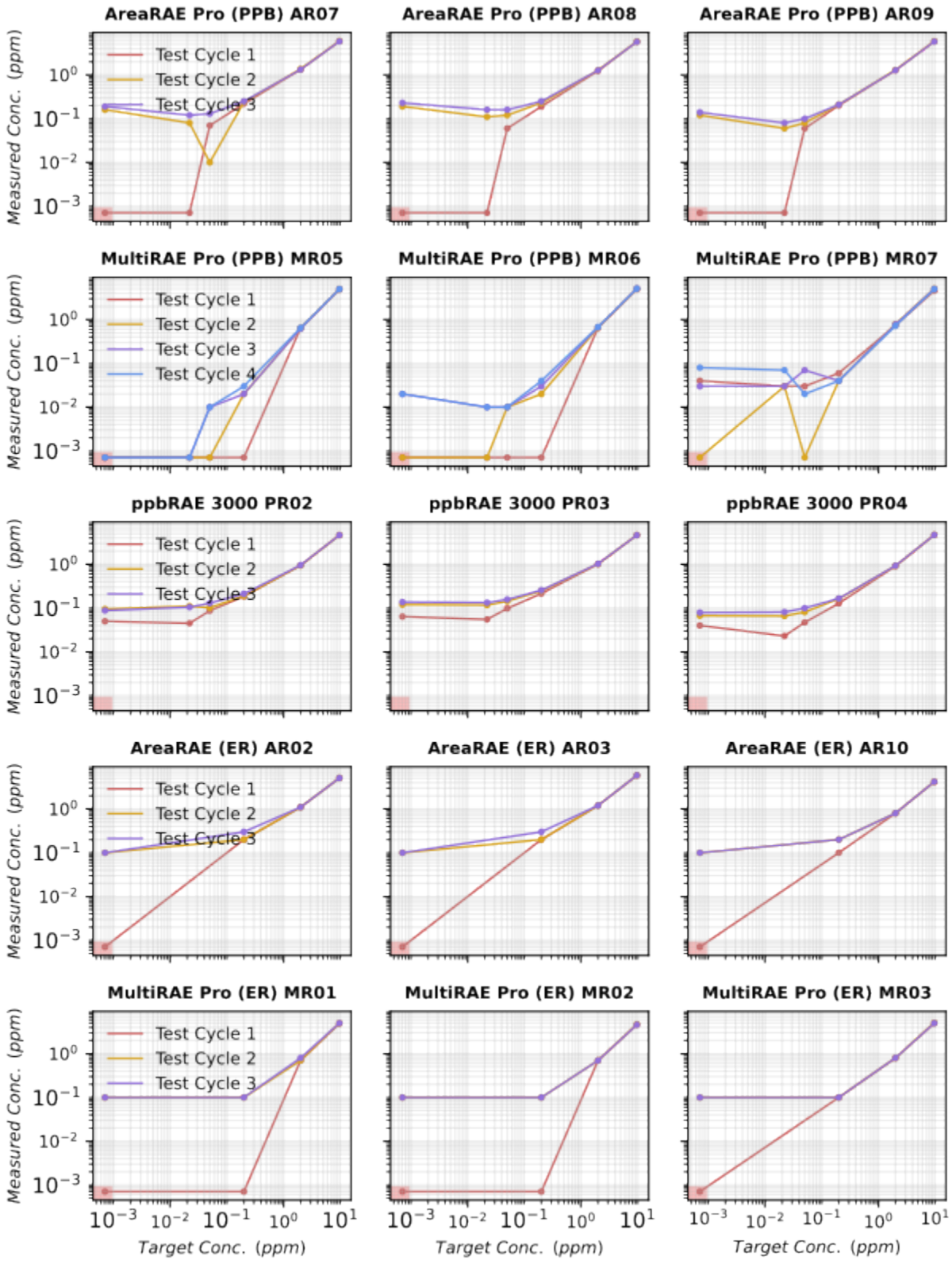
```
########## Target 0.0 ppm Statistics ##########
n: 18
Min (y): 0.0
Max (y): 0.044
Mean (y): 0.002
Mean Corrected Mfg. (y): 0.005
Median (y): 0.0
Sample Standard Deviation (y): 0.01
Variance (y): 0.0
Mean Percent Error Mfg. (y): nan
% Relative Standard Deviation (y): 412.311
MSE: 0.0
Alpha: 0.05
df: (n - 2) = 16
t-value: 2.12
Confidence Interval (y): 0.002 +/- 0.005
Confidence Interval Corrected Mfg. (y): 0.005 +/- 0.01
UCL: 0.007
UCL Mfg. Corrected: 0.015
LCL: -0.003
LCL Mfg. Corrected: -0.005
Prediction Interval (y): 0.002 +/- 0.022
One-sample Mfg. t-test: t-statistic Mfg.=1.0, p-value=0.331332762038679
             Reject Mfg. Ho (ymean = u): False
################################################

########## Target 0.05 ppm Statistics ##########
n: 18
Min (y): 0.0
Max (y): 0.099
Mean (y): 0.037
Mean Corrected Mfg. (y): 0.075
Median (y): 0.041
Sample Standard Deviation (y): 0.031
Variance (y): 0.001
Mean Percent Error Mfg. (y): 49.778
% Relative Standard Deviation (y): 82.407
MSE: 0.004
Alpha: 0.05
df: (n - 2) = 16
t-value: 2.12
Confidence Interval (y): 0.037 +/- 0.015
Confidence Interval Corrected Mfg. (y): 0.075 +/- 0.031
UCL: 0.052
UCL Mfg. Corrected: 0.106
LCL: 0.022
LCL Mfg. Corrected: 0.044
Prediction Interval (y): 0.037 +/- 0.067
One-sample Mfg. t-test: t-statistic Mfg.=1.663, p-value=0.11466974088724463
             Reject Mfg. Ho (ymean = u): False
################################################
```

```
########## Target 0.2 ppm Statistics ##########
n: 15
Min (y): 0.0
Max (y): 0.157
Mean (y): 0.074
Mean Corrected Mfg. (y): 0.148
Median (y): 0.084
Sample Standard Deviation (y): 0.047
Variance (y): 0.002
Mean Percent Error Mfg. (y): -25.933
% Relative Standard Deviation (y): 63.27
MSE: 0.011
Alpha: 0.05
df: (n - 2) = 13
t-value: 2.16
Confidence Interval (y): 0.074 +/- 0.026
Confidence Interval Corrected Mfg. (y): 0.148 +/- 0.052
UCL: 0.1
UCL Mfg. Corrected: 0.2
LCL: 0.048
LCL Mfg. Corrected: 0.096
Prediction Interval (y): 0.074 +/- 0.105
One-sample Mfg. t-test: t-statistic Mfg.=-2.071, p-value=0.05736187942444087
             Reject Mfg. Ho (ymean = u): False
################################################

########## Target 0.981 ppm Statistics ##########
n: 15
Min (y): 0.067
Max (y): 0.53
Mean (y): 0.387
Mean Corrected Mfg. (y): 0.774
Median (y): 0.443
Sample Standard Deviation (y): 0.151
Variance (y): 0.023
Mean Percent Error Mfg. (y): -21.101
% Relative Standard Deviation (y): 38.925
MSE: 0.134
Alpha: 0.05
df: (n - 2) = 13
t-value: 2.16
Confidence Interval (y): 0.387 +/- 0.084
Confidence Interval Corrected Mfg. (y): 0.774 +/- 0.168
UCL: 0.471
UCL Mfg. Corrected: 0.942
LCL: 0.303
LCL Mfg. Corrected: 0.606
Prediction Interval (y): 0.387 +/- 0.336
One-sample Mfg. t-test: t-statistic Mfg.=-2.571, p-value=0.022204446859427747
             Reject Mfg. Ho (ymean = u): True
################################################
```

```
########## Target 4.937 ppm Statistics ##########
n: 15
Min (y): 1.89
Max (y): 2.529
Mean (y): 2.276
Mean Corrected Mfg. (y): 4.552
Median (y): 2.327
Sample Standard Deviation (y): 0.202
Variance (y): 0.041
Mean Percent Error Mfg. (y): -7.804
% Relative Standard Deviation (y): 8.866
MSE: 0.311
Alpha: 0.05
df: (n - 2) = 13
t-value: 2.16
Confidence Interval (y): 2.276 +/- 0.113
Confidence Interval Corrected Mfg. (y): 4.552 +/- 0.225
UCL: 2.389
UCL Mfg. Corrected: 4.777
LCL: 2.163
LCL Mfg. Corrected: 4.327
Prediction Interval (y): 2.276 +/- 0.45
One-sample Mfg. t-test: t-statistic Mfg.=-3.572, p-value=0.003062435913069952
             Reject Mfg. Ho (ymean = u): True
##################################################

########## Target 9.736 ppm Statistics ##########
n: 15
Min (y): 4.195
Max (y): 4.914
Mean (y): 4.596
Mean Corrected Mfg. (y): 9.192
Median (y): 4.623
Sample Standard Deviation (y): 0.22
Variance (y): 0.048
Mean Percent Error Mfg. (y): -5.59
% Relative Standard Deviation (y): 4.784
MSE: 0.49
Alpha: 0.05
df: (n - 2) = 13
t-value: 2.16
Confidence Interval (y): 4.596 +/- 0.123
Confidence Interval Corrected Mfg. (y): 9.192 +/- 0.245
UCL: 4.719
UCL Mfg. Corrected: 9.437
LCL: 4.473
LCL Mfg. Corrected: 8.947
Prediction Interval (y): 4.596 +/- 0.491
One-sample Mfg. t-test: t-statistic Mfg.=-4.631, p-value=0.0003889027695753932
             Reject Mfg. Ho (ymean = u): True
##################################################
```

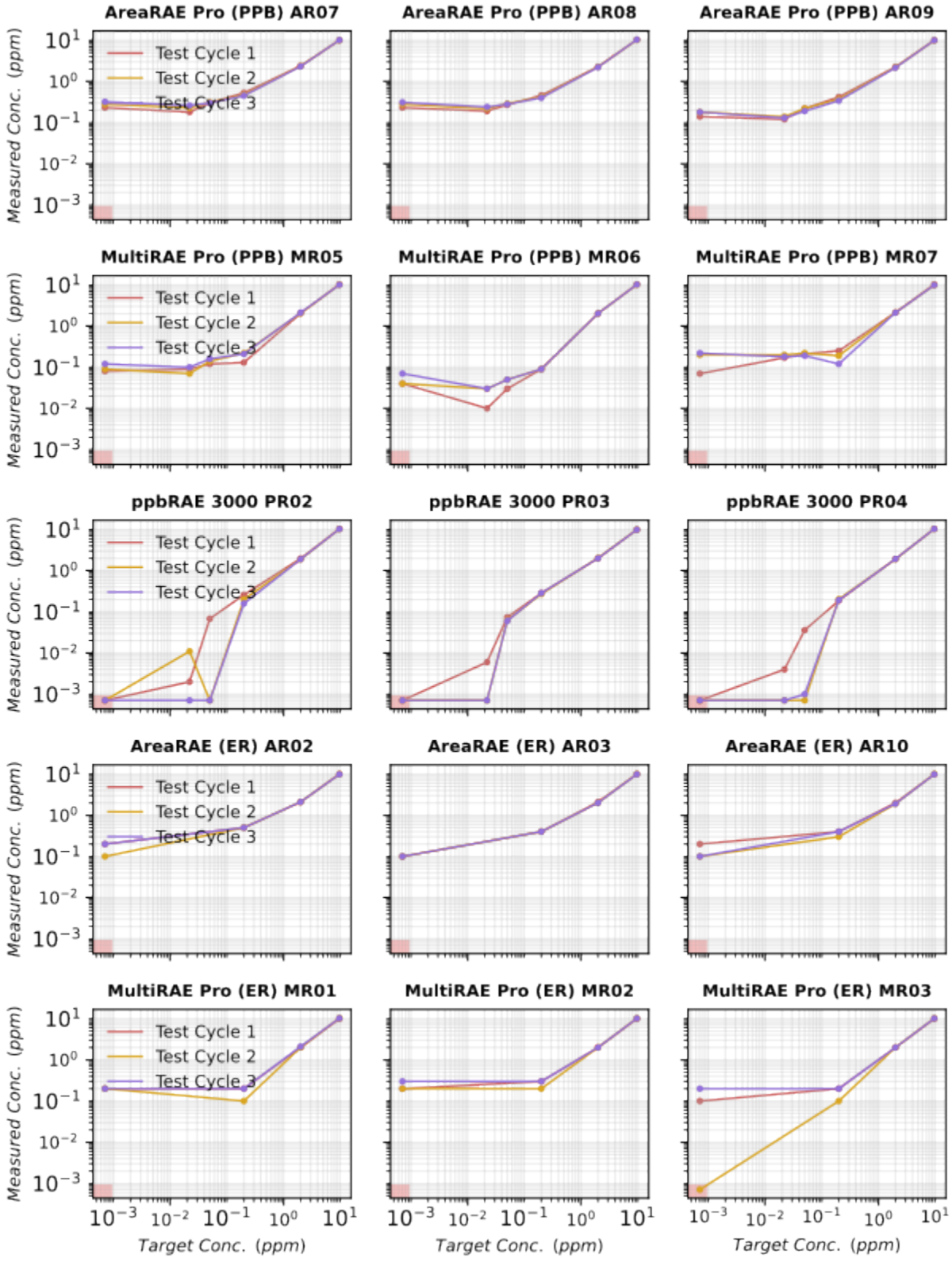
Appendix D: Test Cycle Graphs

Butyl Acrylate Test Cycles



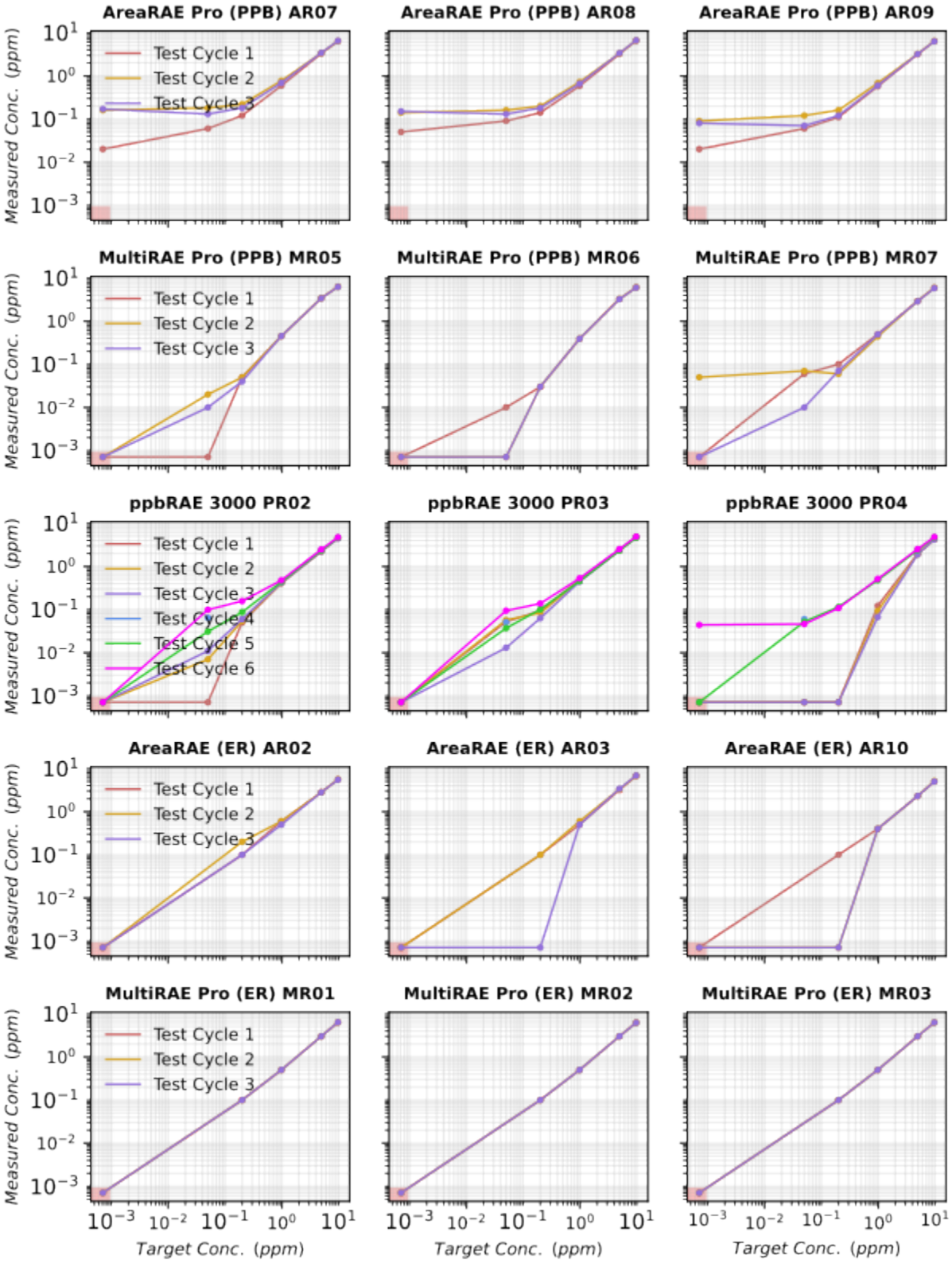
All zero values on the x-axis and y-axis substituted with $0.001/\sqrt{2}$ to accommodate the log scale. Points within the bounds of the red box in the lower left corner should be considered equivalent to zero response.

Butyl Acrylate Calibrated Test Cycles



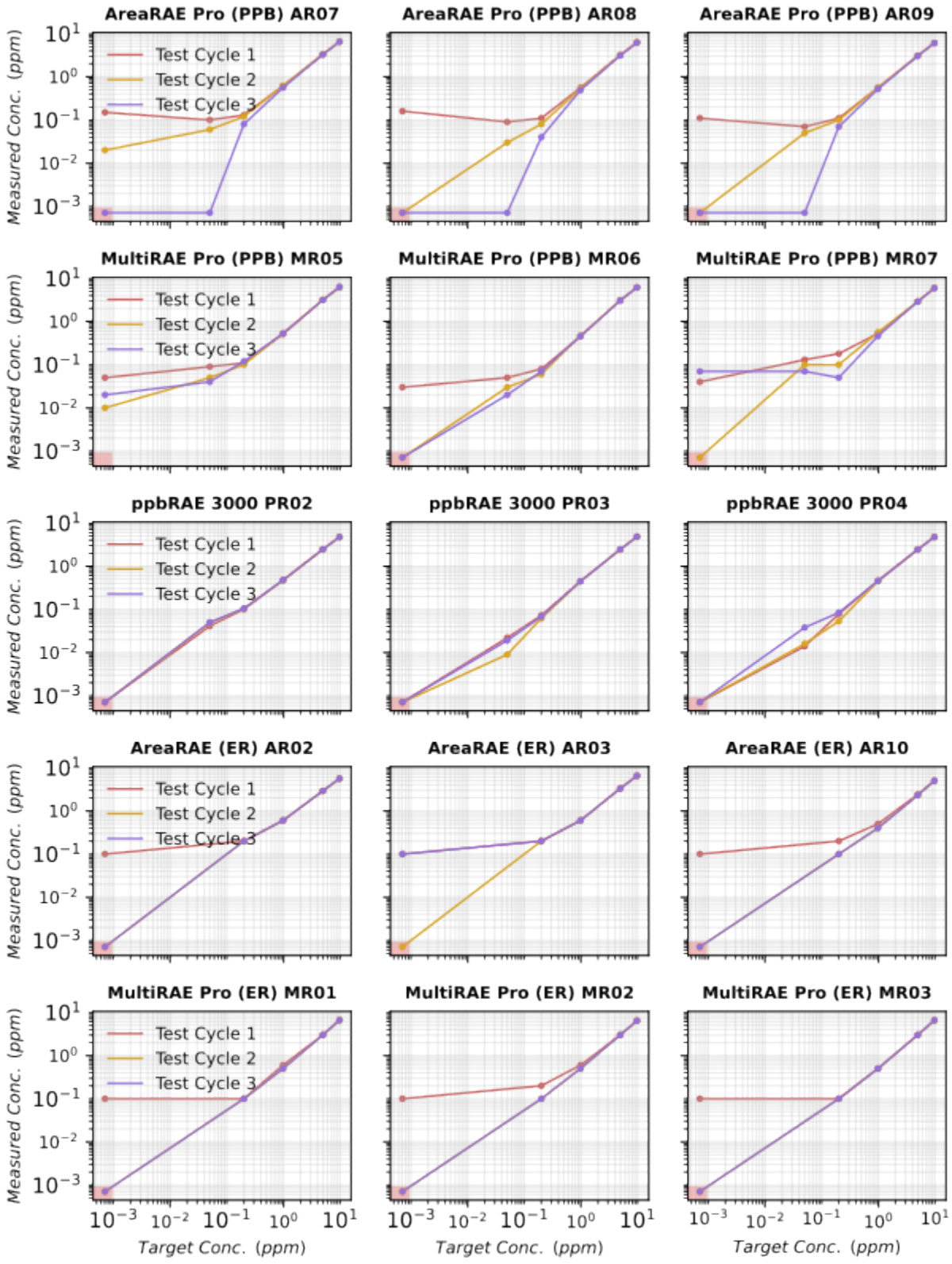
All zero values on the x-axis and y-axis substituted with $0.001/\sqrt{2}$ to accommodate the log scale. Points within the bounds of the red box in the lower left corner should be considered equivalent to zero response.

Vinyl Chloride Test Cycles



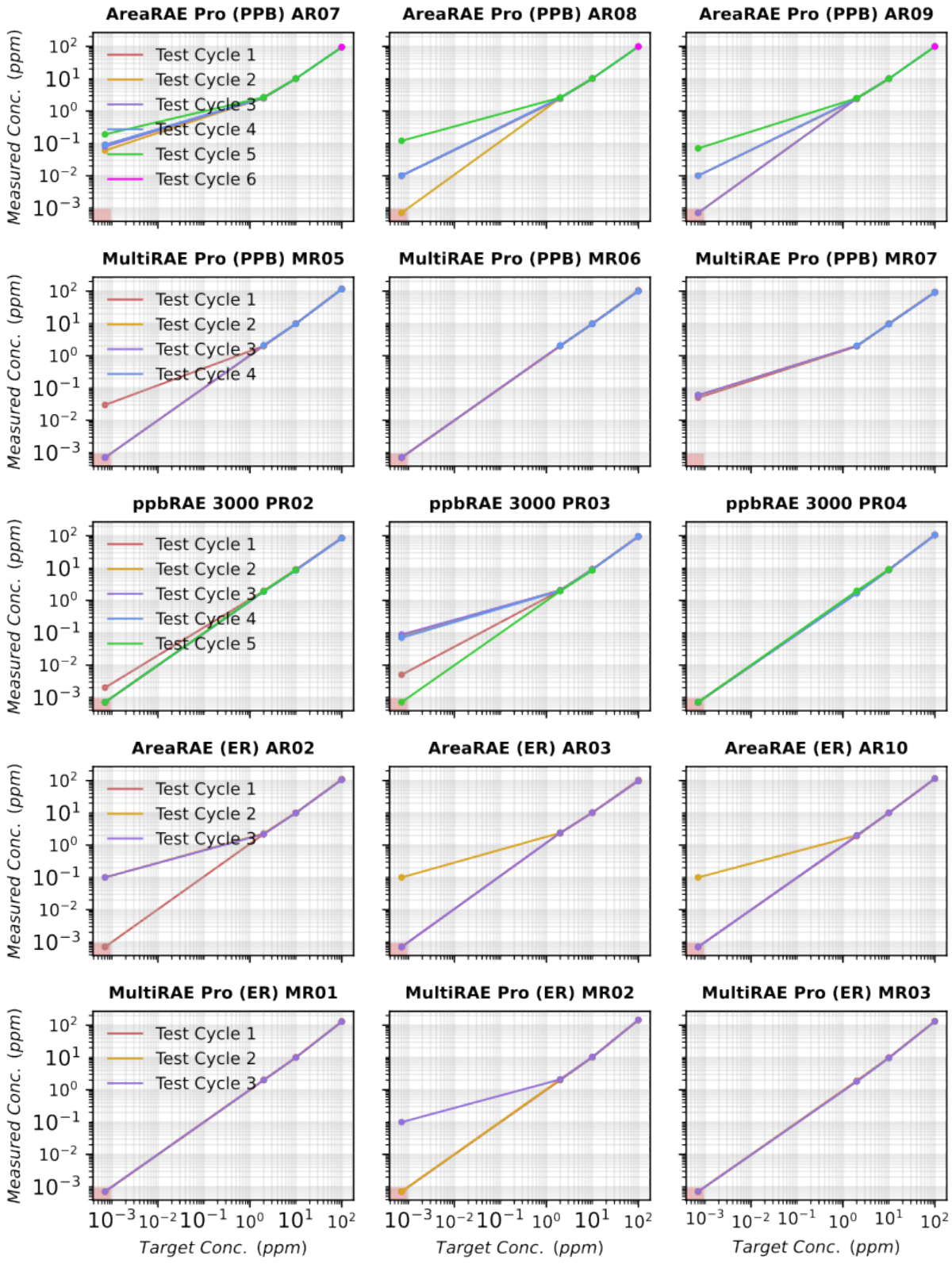
All zero values on the x-axis and y-axis substituted with $0.001/\sqrt{2}$ to accommodate the log scale. Points within the bounds of the red box in the lower left corner should be considered equivalent to zero response.

Vinyl Chloride Post-Butyl Acrylate Test Cycles



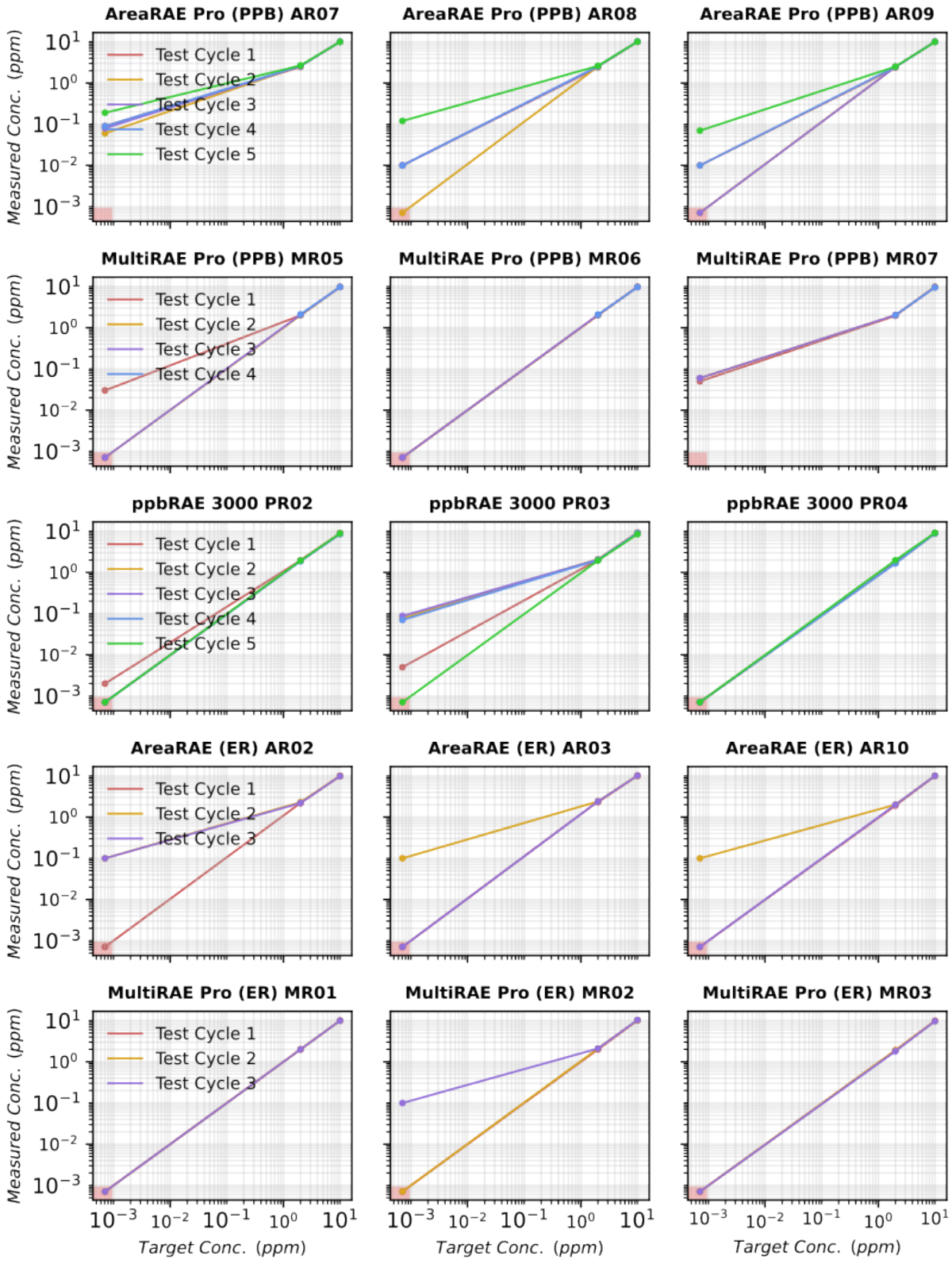
All zero values on the x-axis and y-axis substituted with $0.001/\sqrt{2}$ to accommodate the log scale. Points within the bounds of the red box in the lower left corner should be considered equivalent to zero response.

Isobutylene Test Cycles



All zero values on the x-axis and y-axis substituted with $0.001/\sqrt{2}$ to accommodate the log scale. Points within the bounds of the red box in the lower left corner should be considered equivalent to zero response.

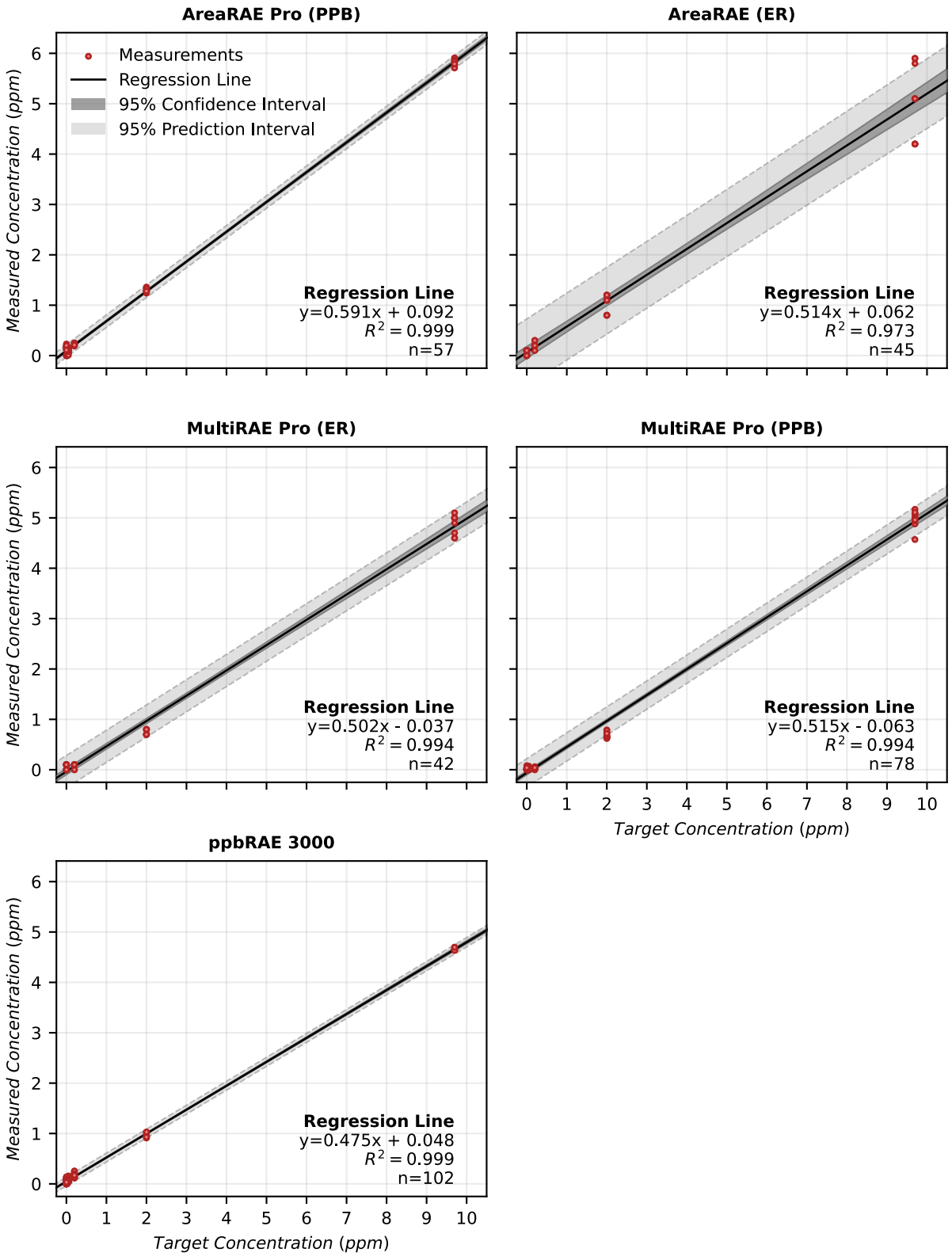
Isobutylene Calibration Test Cycles



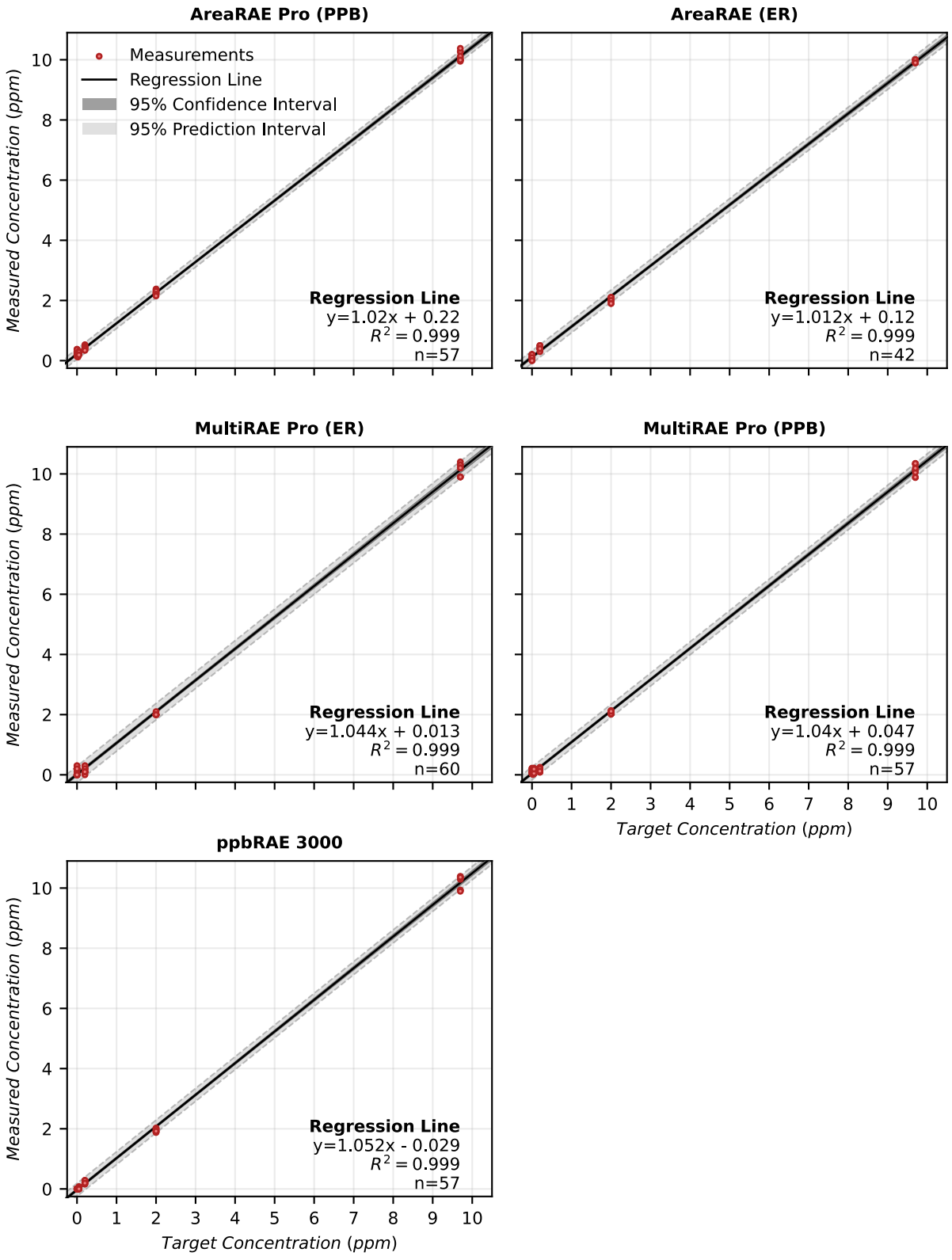
All zero values on the x-axis and y-axis substituted with $0.001/\sqrt{2}$ to accommodate the log scale. Points within the bounds of the red box in the lower left corner should be considered equivalent to zero response.

Appendix E: Linear Regression Graphs

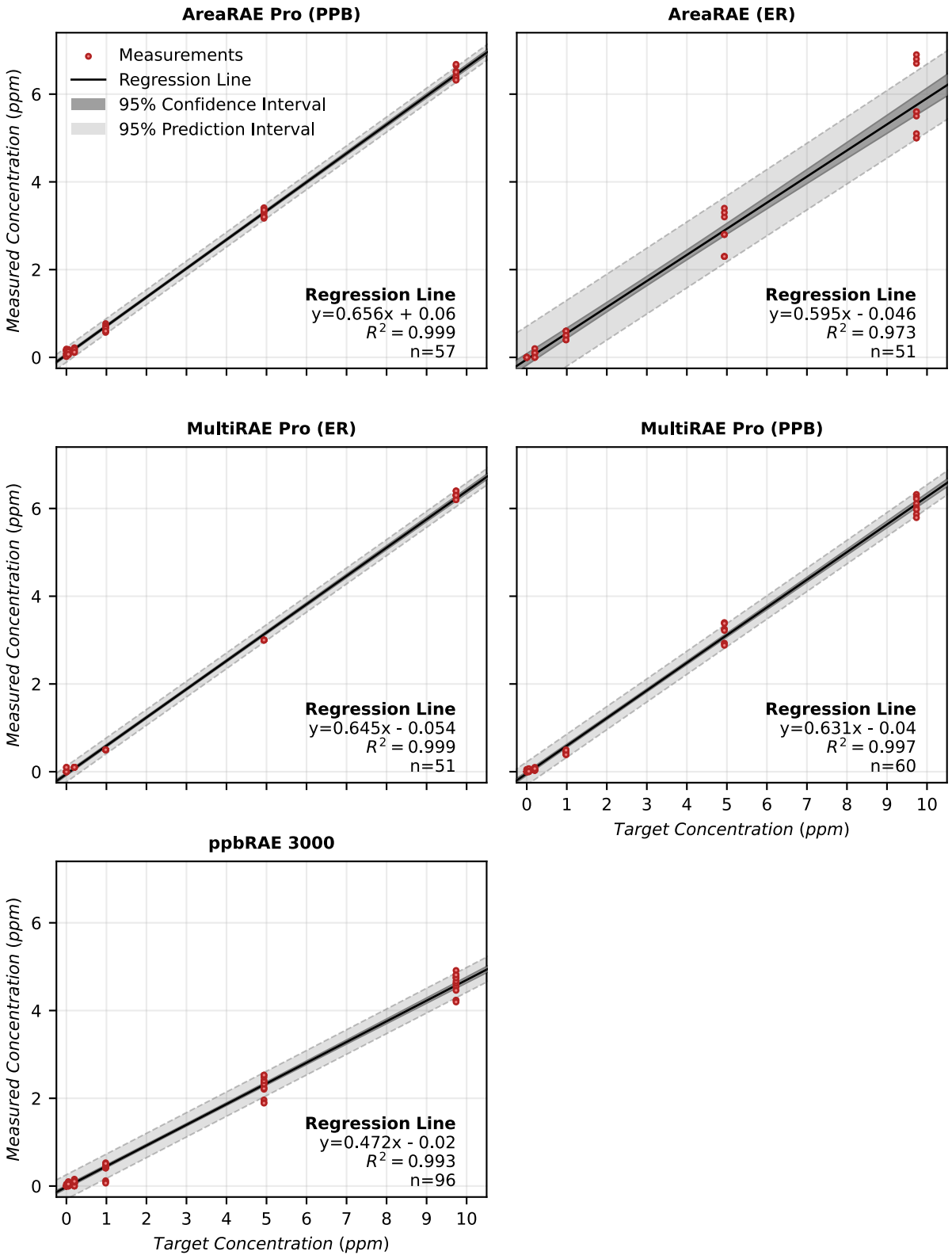
Butyl Acrylate Test Linear Regression



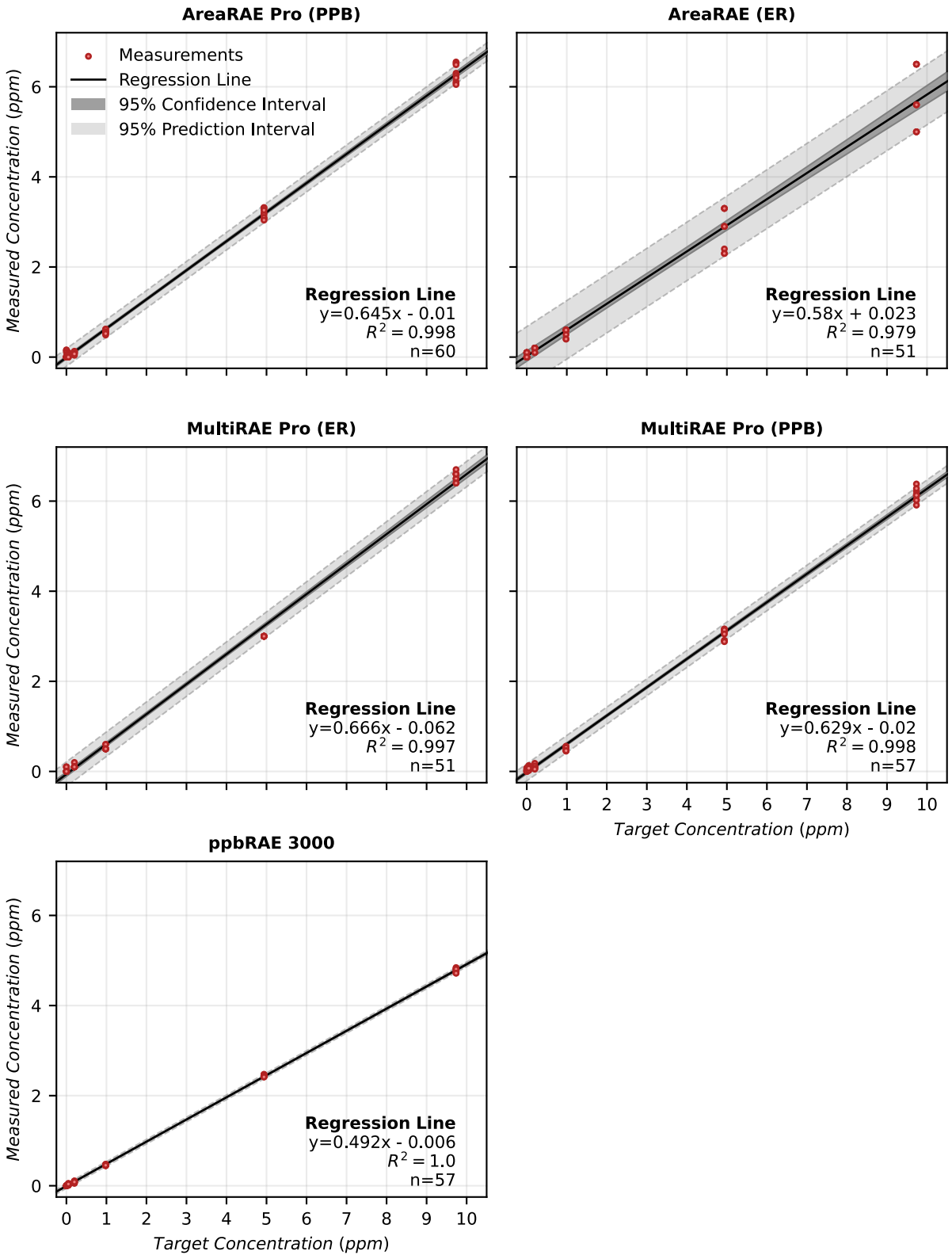
Butyl Acrylate Calibrated Test Linear Regression



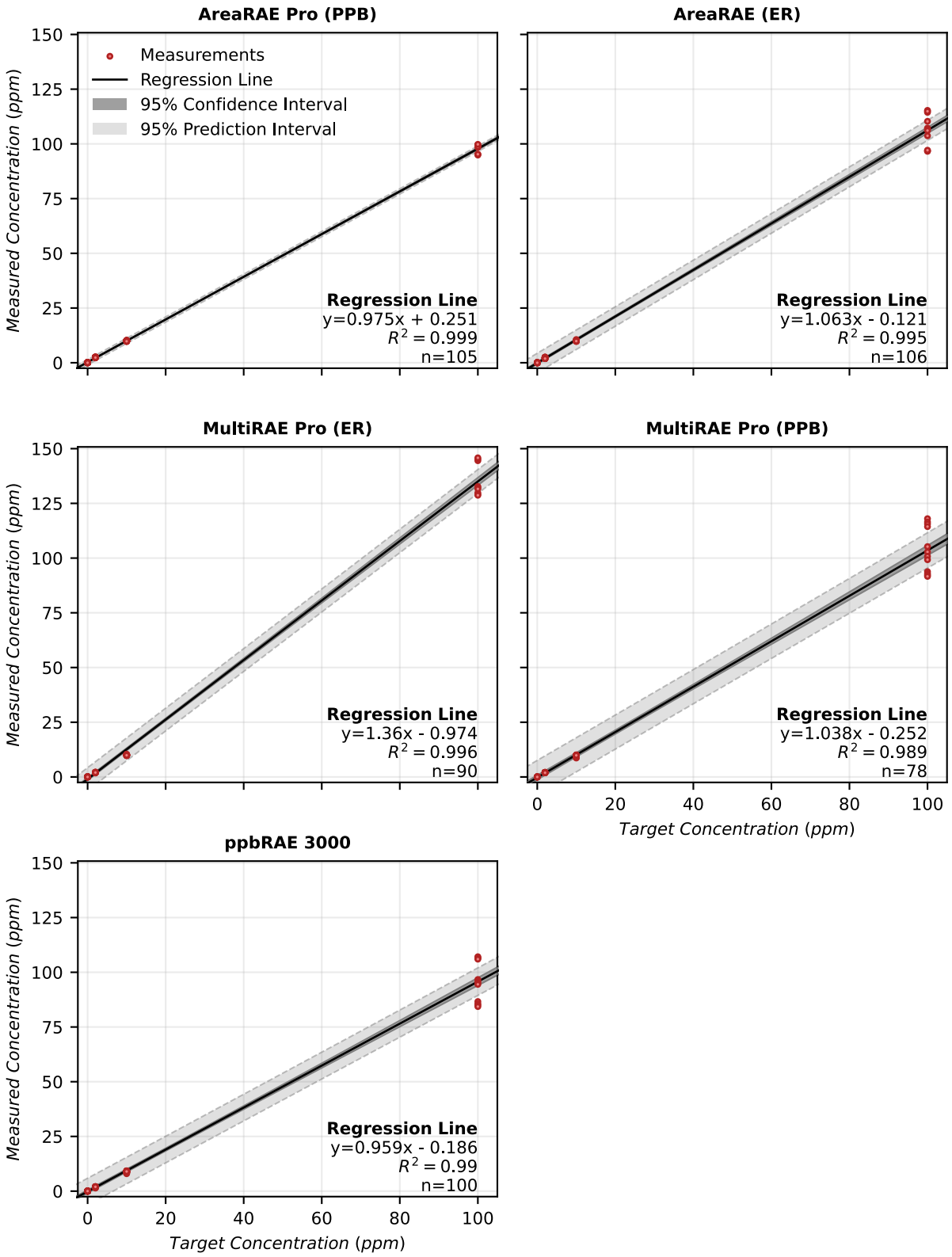
Vinyl Chloride Test Linear Regression



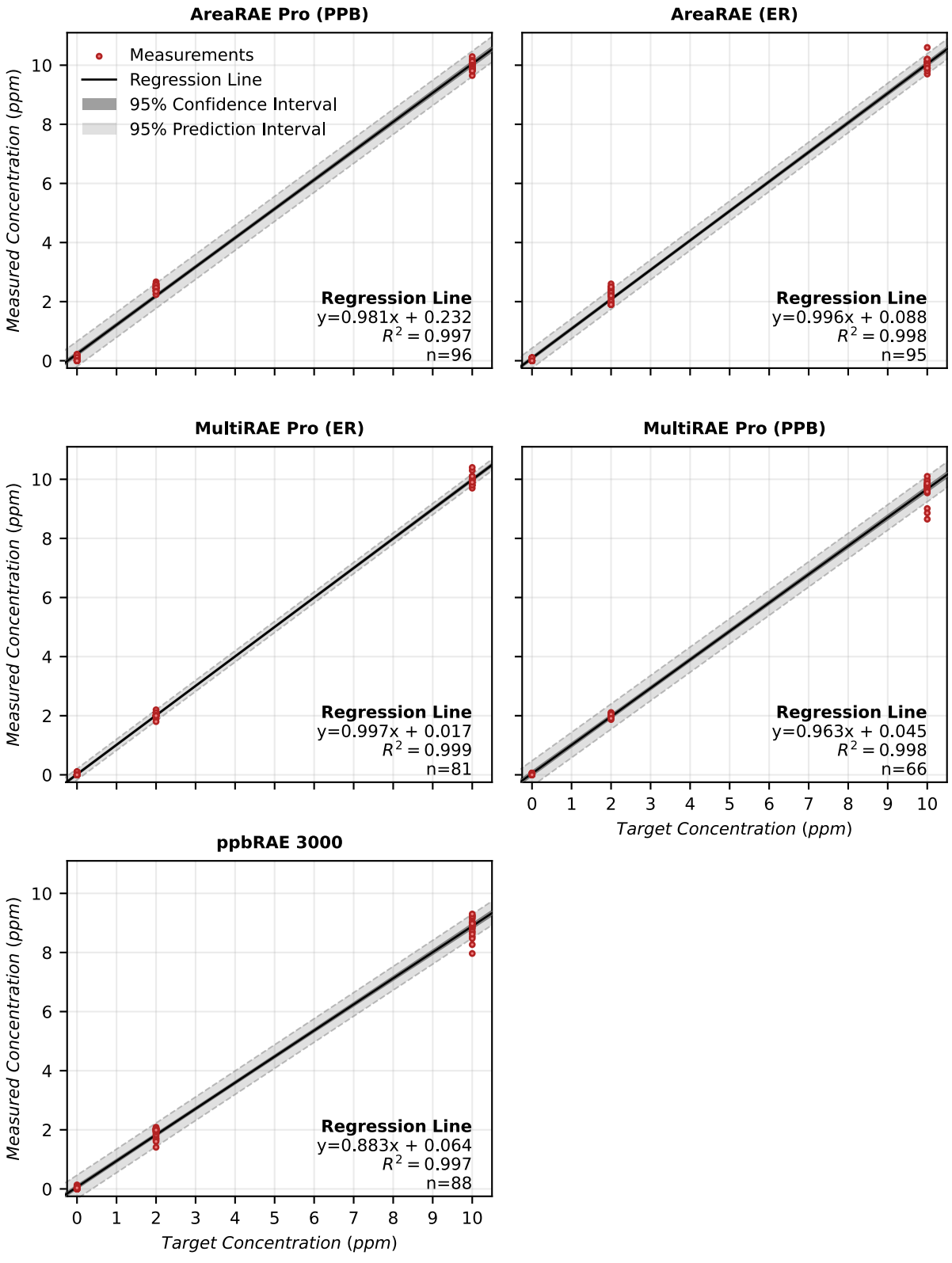
Vinyl Chloride Post-Butyl Acrylate Test Linear Regression



Isobutylene Test Linear Regression

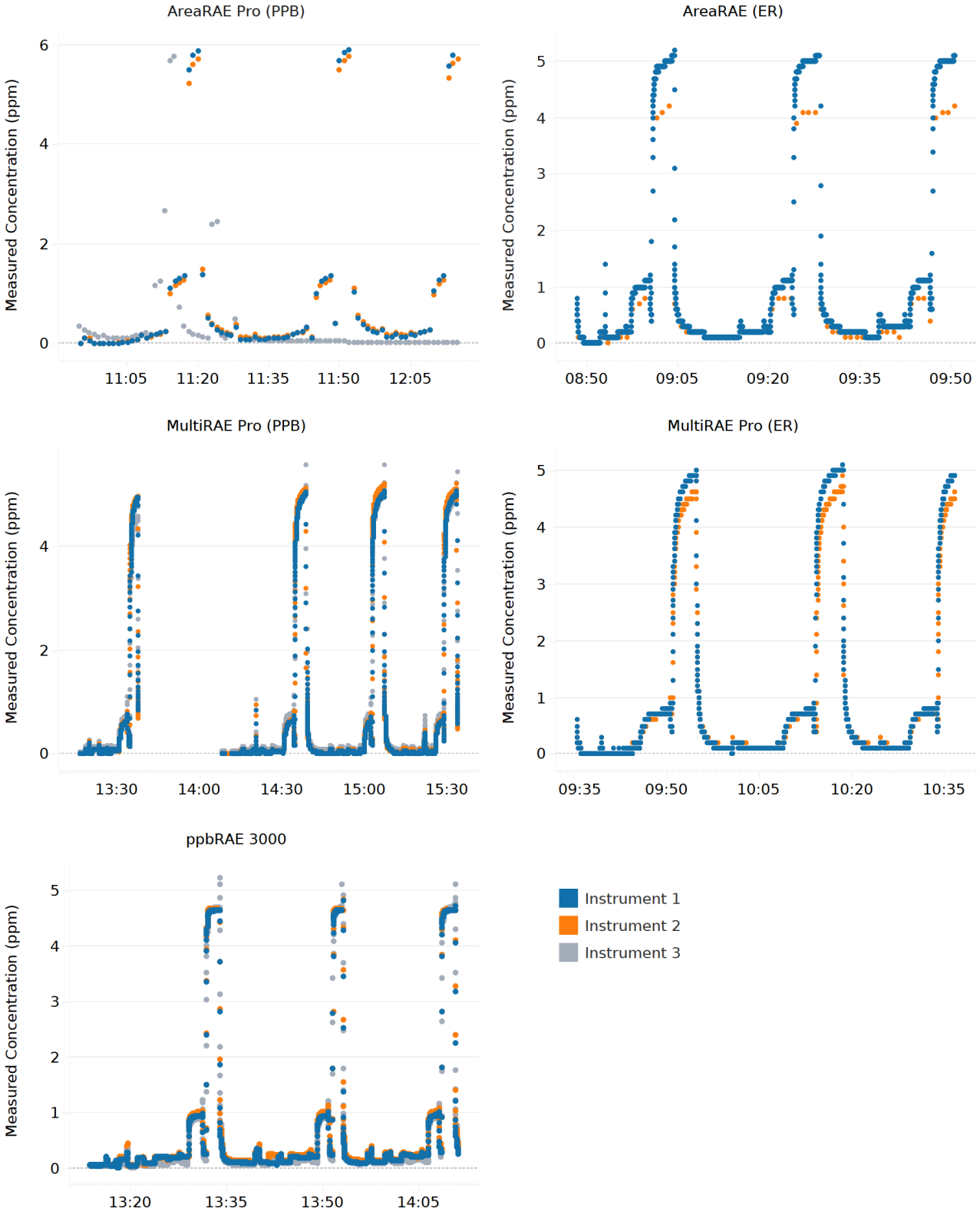


Isobutylene Calibration Linear Regression



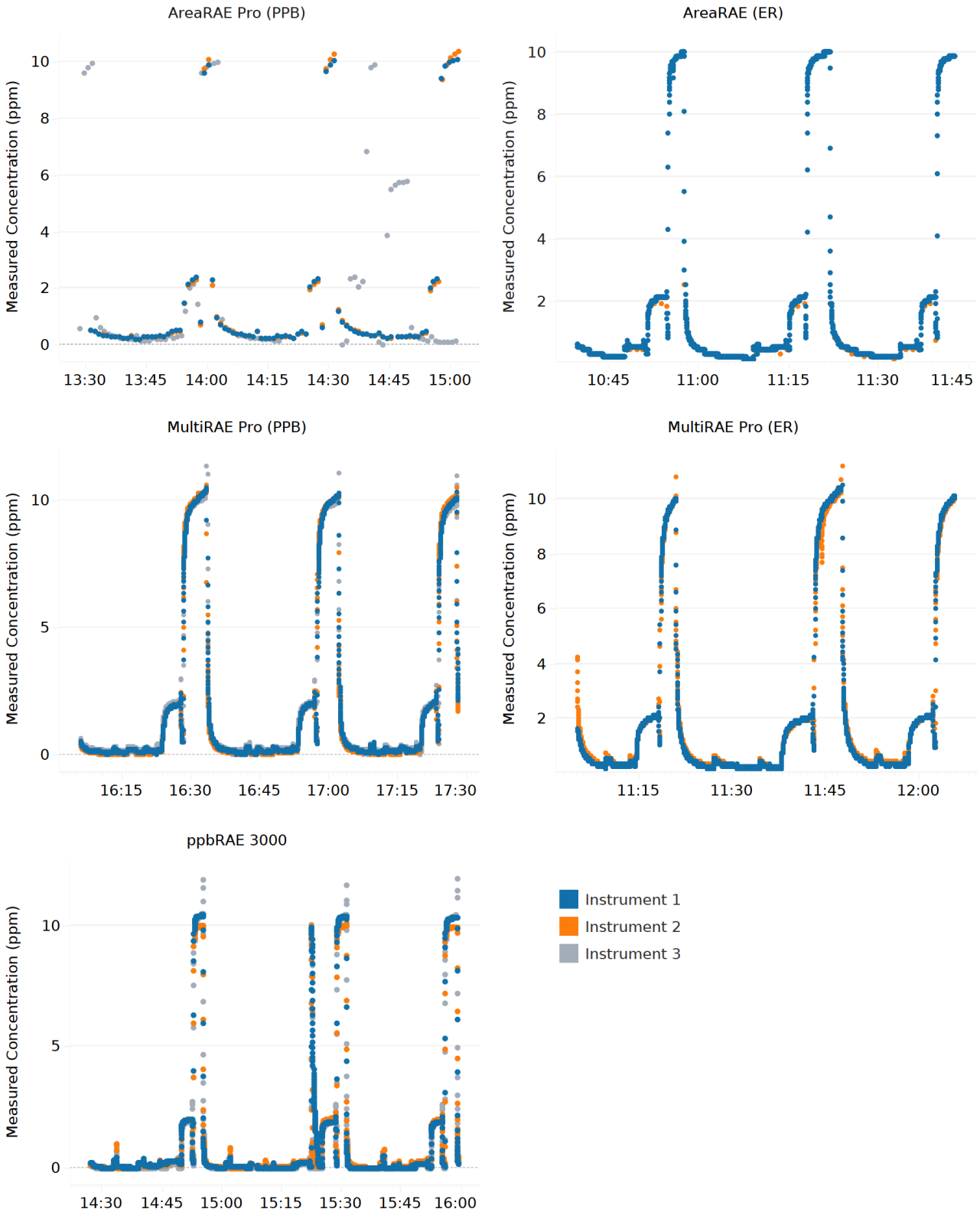
Appendix F: Data Log Graphs

Butyl Acrylate Test



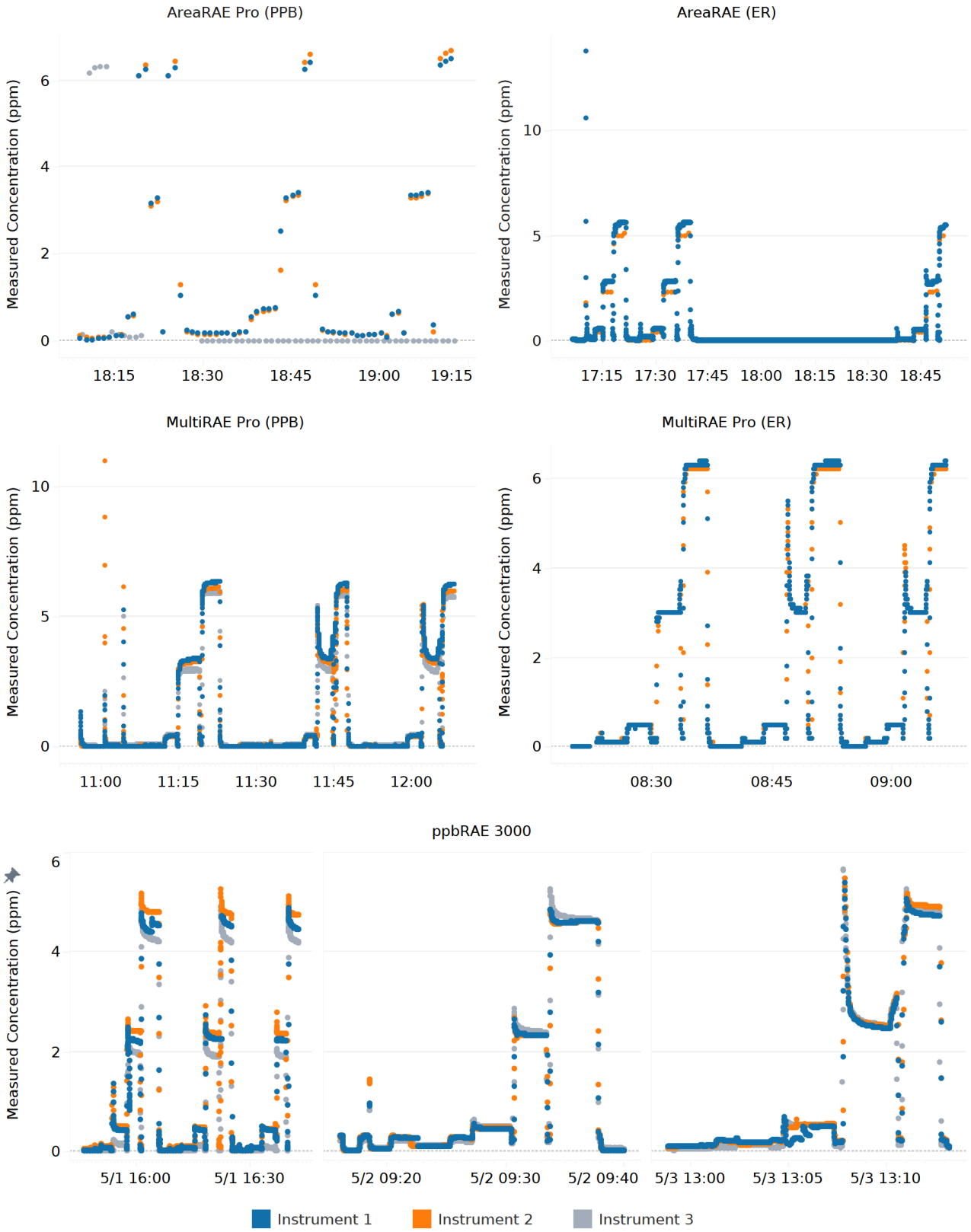
Data from instrument data logs have not undergone full quality control checks. Instruments were data logged continually while powered on and may contain records that occurred during equipment configuration, maintenance tests, or are otherwise erroneous. These graphs are provided for cursory evaluation only and as an illustration of the instrument test cycle process.

Butyl Acrylate Calibrated Test



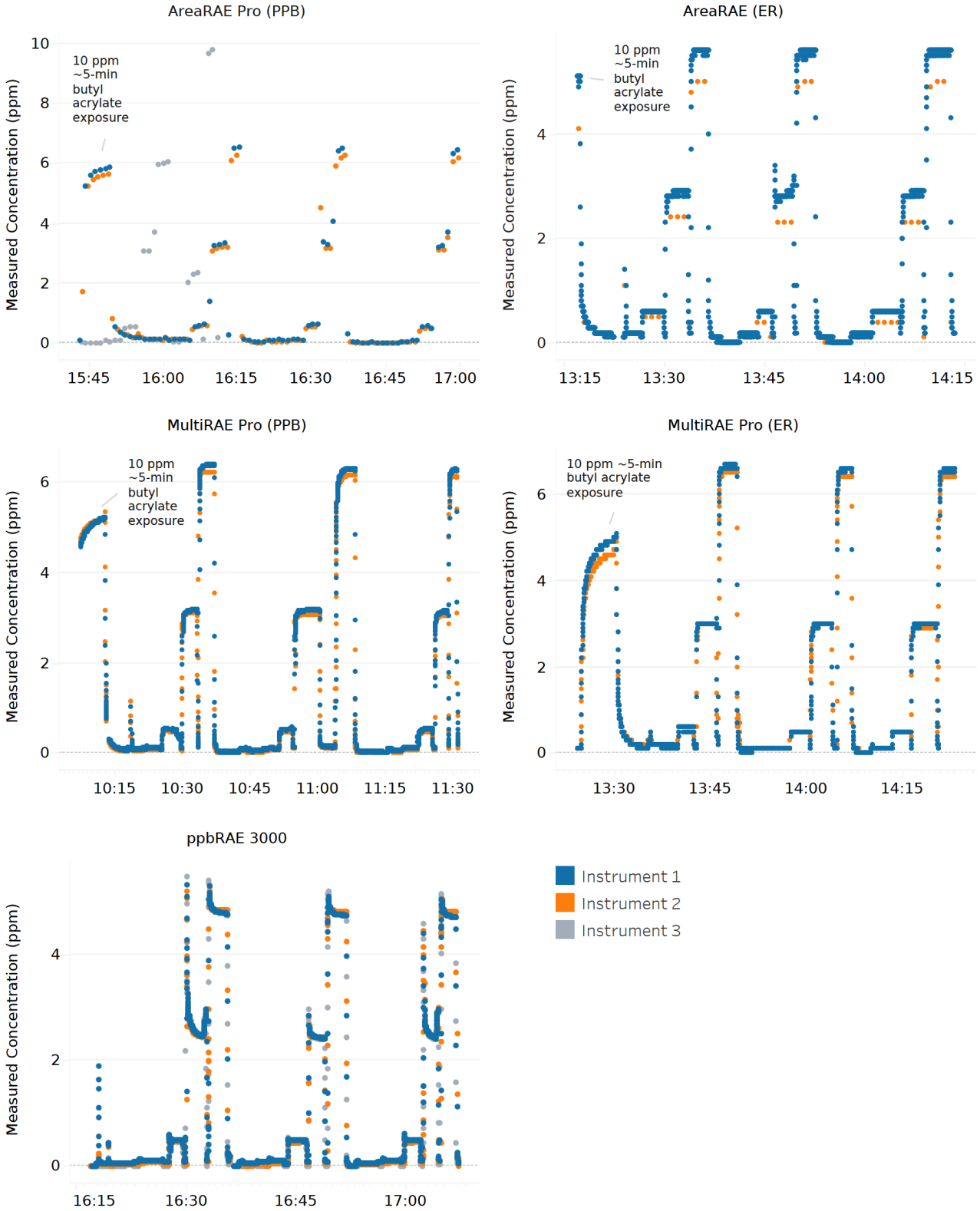
Data from instrument data logs have not undergone full quality control checks. Instruments were data logged continually while powered on and may contain records that occurred during equipment configuration, maintenance tests, or are otherwise erroneous. These graphs are provided for cursory evaluation only and as an illustration of the instrument test cycle process.

Vinyl Chloride Test



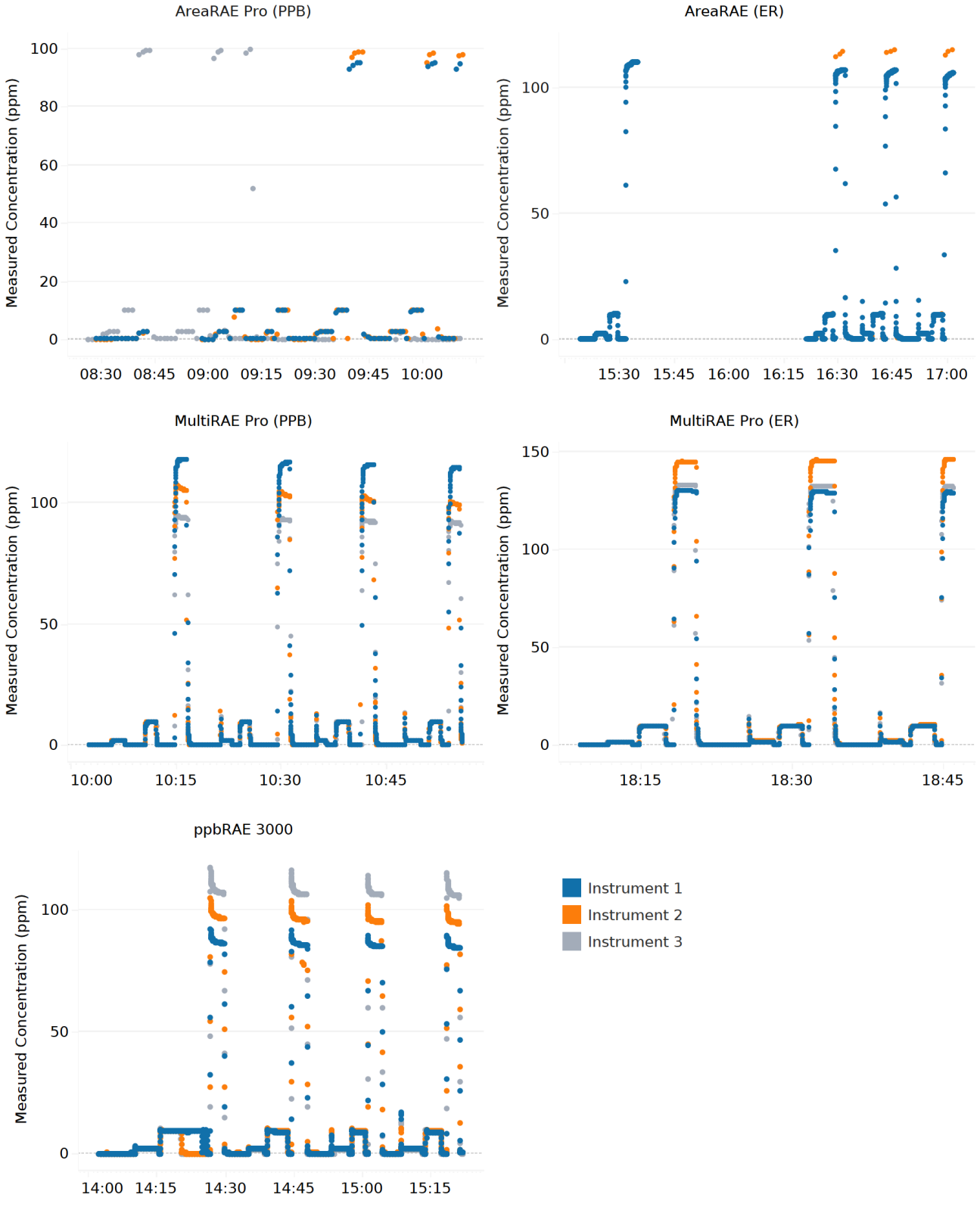
Data from instrument data logs have not undergone full quality control checks. Instruments were data logged continually while powered on and may contain records that occurred during equipment configuration, maintenance tests, or are otherwise erroneous. These graphs are provided for cursory evaluation only and as an illustration of the instrument test cycle process.

Vinyl Chloride Post Butyl Acrelate Exposure



Data from instrument data logs have not undergone full quality control checks. Instruments were data logged continually while powered on and may contain records that occurred during equipment configuration, maintenance tests, or are otherwise erroneous. These graphs are provided for cursory evaluation only and as an illustration of the instrument test cycle process. While 10 ppm butyl acrylate was inadvertently not supplied to the ppbRAE PID between instrument re-calibration and the vinyl-chloride post butyl acrylate exposure test, the test immediately prior was the butyl acrylate calibrated test.

Isobutylene Test



Data from instrument data logs have not undergone full quality control checks. Instruments were data logged continually while powered on and may contain records that occurred during equipment configuration, maintenance tests, or are otherwise erroneous. These graphs are provided for cursory evaluation only and as an illustration of the instrument test cycle process.

Appendix G: Assessment Temperature, Humidity, and Pressure Measurements

Table G.1 contains indoor ambient temperature, relative humidity, and barometric pressure measurements recorded inside the Centenary United Methodist Church (CUMC) located in East Palestine, Ohio, which was used as the East Palestine Train Derailment Forward Operating Base and to conduct the PID assessment.

Table G.1 Indoor Ambient Temperature, Relative Humidity, and Barometric Pressure Measurements

Date	Time	Temp (F)	Relative Humidity (%)	Barometric Pressure (hPa)
May 3rd	10:23	74.3	37.7	967.2
	13:50	73.3	41.5	968.3
	15:34	73	41.9	NR
May 4th	7:49	71.9	40.5	977.8
	11:52	72.7	41.8	979.7
	16:55	74.3	40.7	980.8
May 5th	10:08	72.8	40.9	988
	14:07	73.5	37.5	987.3
	15:18	75	39.2	987.4
May 6th	09:07	70.3	43.9	990.2
	11:28	72.1	40.2	982.2
	13:53	74.1	34.4	987.5

NR=Not Recorded