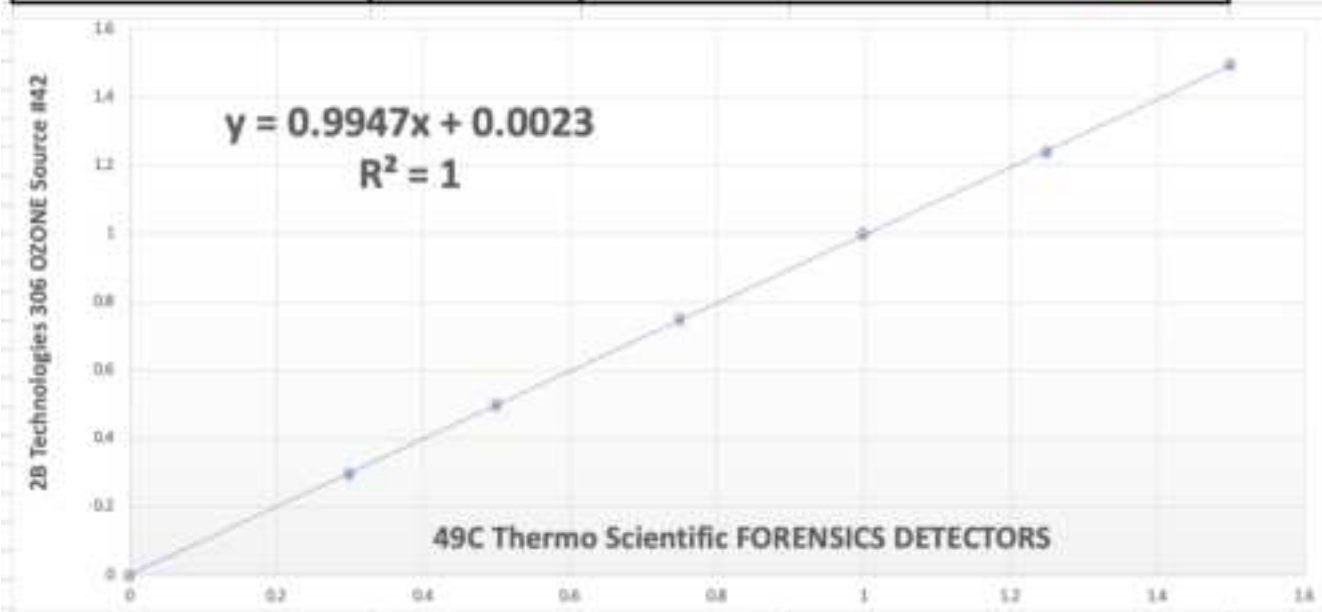


## OZONE CALIBRATION TO NIST TRACEABILITY

<b>Calibration Date:</b>	08/25/2025
<b>Performed By:</b>	Dr. Koz Galatsis, Chief Engineer at Forensics Detectors
<b>Location:</b>	Los Angeles, CA – Forensics Detectors Laboratory
<b>Description:</b>	OZONE Calibration to NIST Traceable Source
<b>NIST Traceability:</b>	<ol style="list-style-type: none"> <li>1. A Thermo Electron O3 Primary Standard 49i-PS serial number 072724741 owned by 2B Technologies, this unit is called the <b>Transfer Standard</b>. This machine was calibrated to the primary standard by NIST against their Standard Reference Photometer, serial number 0 in Gaithersburg, MA on 14/05/2024.</li> <li>2. Then a <b>Working Standard</b> was employed, which is a 2B Technologies Model 205 Ozone Monitor. This was calibrated by 2B Technologies to the transfer standard 49i on 31/12/2024.</li> <li>3. Then the Forensics Detectors owned 2B Technologies Model 306 Ozone Source, Serial #42 was calibrated to the working standard on 08/06/2025. This is called the <b>Forensics Standard</b>.</li> <li>4. The Forensics Standard was used to calibrate the “Forensics” standard 49C OZONE Calibrator, Primary Standard, Thermo Environmental Instruments, Serial Number 49CPS-74543-376. Calibrated on 08/25/25.</li> </ol>
<b>Forensics Detectors OZONE Analyzer</b>	49C OZONE Calibrator, Primary Standard, Thermo Environmental Instruments, Serial Number 49CPS-74543-376.
<b>Overall PASS / FAIL</b>	<b>PASS</b>
<b>Calibration Conditions</b>	75F @ 50% RH
<b>Accuracy</b>	Better than 2% of reading from 0 -1ppm
<b>Cal adjustments to Instrument required?</b>	None. 49C was in calibration and operating very nicely, stable and accurately per its expected performance & specs. Cal coefficient factor was left at 1.0000.

306 OZONE Source	49C Results	Deviation	%Deviation	PASS / FAIL
0	0.0005	0		PASS
0.3	0.299	0.001	0.33%	PASS
0.5	0.501	-0.001	-0.20%	PASS
0.75	0.752	-0.002	-0.27%	PASS
1	1.001	-0.001	-0.10%	PASS
1.25	1.239	0.011	0.88%	PASS
1.5	1.495	0.005	0.33%	PASS



Based on the following unbroken chain of comparisons that are based on the US National Institute of Standard and Technology (NIST), FORENSICS DETECTORS calibrates all of its sold ozone meters, detectors, analyzers and monitors to either:

1. 49C OZONE Calibrator, Primary Standard, Thermo Environmental Instruments, Serial Number 49CPS-74543-376.
2. 2B Technologies Model 306 Ozone Source, Serial #42

As such, it designates the calibration of all its sold ozone gas measurement products to be NIST traceable.

See attached:

1. Calibration Certificate of 2B Technologies Model 306 (#42)
2. Calibration SOP followed is SOP-CAL-002 (see attached)

**Dr. Koz, Chief Engineer**

**Date: 08/25/2025**



## Technologies Model 306 Ozone Calibration Source™ Calibration Certificate

Calibration Description:	NIST Traceable Calibration of Ozone Monitors		
Calibration ID Number:	306_042_060825		
Location:	2B Tech., 6800 W 117th Ave, Broomfield, CO 80020		
Calibration Lab Conditions:	22.9 °C	29 %RH	
Instrument Model:	306		
Instrument S/N:	42		
Slope:	0.98		
Offset, ppbv:	2		
Measurement Uncertainty (ppbv) <sup>1,2</sup> :	4.7		
2B Spec, Accuracy and Precision:	both: greater of 2 ppbv or 2% of reading		
Overall Pass/Fail:	PASS		
205 Working Standard S/N:	773		
Transfer Standard Calibration Date:	14-May-24		
Working Standard Calibration Date:	31-Dec-24		
Date of Calibration:	06-Aug-25		
Cal Expiration Date:	05-Aug-26		

Based on the following calibration provided by the U.S. National Institute of Standards and Technology (NIST), 2B Technologies designates the calibration of all Ozone Calibration Sources™ to be NIST traceable through an unbroken chain of comparisons. The transfer standard is used to calibrate the working standard, which in turn is used to calibrate the customer's instrument. Each step in the chain is fully documented.

**Transfer standard.** Our transfer standard is a Thermo Electron O3 Calibration Primary Standard, model 49I-PS, serial number 0726724741. The transfer standard was calibrated by NIST against their Standard Reference Photometer, serial number 0, in Gaithersburg, MD on the date above. Measurements were collected of ten concentrations (25 to 1000 ppbv) and two zero concentrations. A linear regression was fit to the data and calibration factors were determined for the transfer standard.

**Working standard.** Our working standard is a 2B Technologies Model 205 Ozone Monitor. The working standard was calibrated by 2B Technologies by comparison to our transfer standard. Measurements were collected of six concentrations (50 to 300 ppbv) and one zero concentration. A linear regression was fit to the data and calibration factors were determined for the working standard.

**Customer's instrument.** Each Ozone Calibration Source™ was calibrated against the working standard. The output of the Ozone Calibration Source™ was drawn into the working standard through a sampling tee and measured. Ten measurements were collected at nine different concentration settings (25 to 1000 ppbv) and one zero concentration. A linear regression was fit to the data and calibration factors were determined.

Cal performed by: Lizzie Hackler

Signature:

calibration date:

06-Aug-25

1. N=2; 95% confidence

2. References: NIST Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results 1994 ed.  
Taylor, John. *An Introduction to Error Analysis*, 2nd ed. Univ. Science Books: Sausalito, 1997.

# 2B Technologies Model 306 Ozone Calibration Source™

## Calibration Data

Serial Number: 42

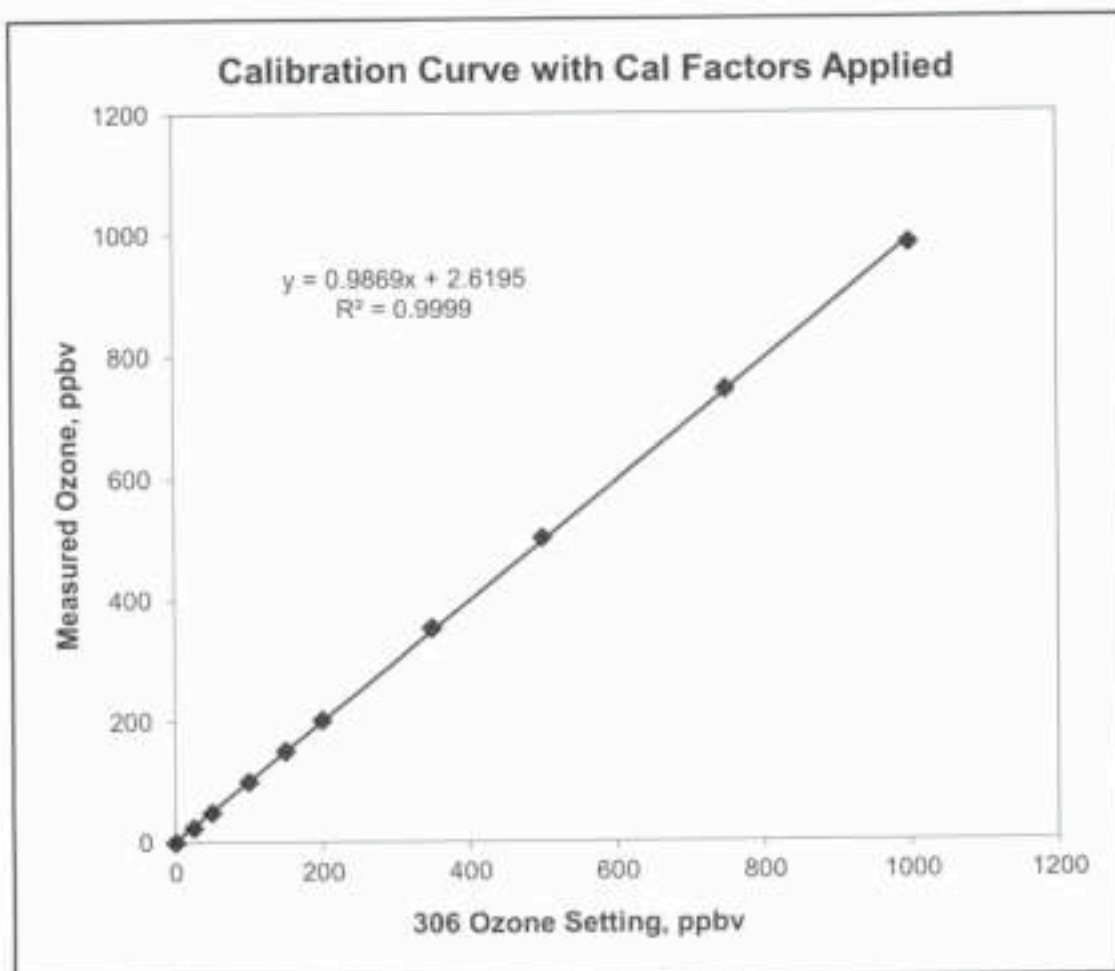
Date: 06-Aug-25

Calibration Factors:

Z= 2

S= 0.98

Setting	Meas.	Deviation	% Dev	Std Dev	Pass/Fail
1000.0	983.1	-16.9	-1.7	1.4	PASS
750.0	745.2	-4.8	-0.6	1.3	PASS
500.0	501.9	1.9	0.4	0.9	PASS
350.0	352.6	2.6	0.8	0.7	PASS
200.0	201.7	1.7	0.9	0.8	PASS
150.0	150.9	0.9	0.6	0.7	PASS
100.0	100.7	0.7	0.7	0.7	PASS
50.0	50.0	0.0	0.0	0.9	PASS
25.0	24.1	-0.9	-3.5	0.7	PASS
0.0	0.0	0.0	n/a	0.9	PASS



## **2.B** Technologies Model 306 Ozone Calibration Source™ Instrument Specifications

<b>Serial Number:</b>	<b>42</b>
Calibration Date	06-Aug-25
Slope	0.98
Offset, ppbv	2
Solenoid Valve	Pneutronics (NPB)
Air Pump	Parker
Ozone Scrubber	Headline
Firmware Version	5.2B
PCB Version	F

# METHOD

## Calibration of Ozone Gas Detectors

**Document ID:** SOP-CAL-002

**Revision:** 1.0

**Effective Date:** August 25th, 2025

### 1. Purpose and Scope

#### 1.1 Purpose

This Standard Operating Procedure (SOP) describes the method for calibrating ozone (O<sub>3</sub>) gas detectors to ensure accurate measurement of ozone concentrations in accordance with ISO/IEC 17025:2017 requirements.

#### 1.2 Scope

This procedure applies to the calibration of ozone detectors and analyzers used for the detection and measurement of ozone gas. The calibration process involves both zero calibration using fresh air or nitrogen, and span calibration using a NIST-traceable calibrated ozone generator and/or ozone analyzer.

### 2. References

- ISO/IEC 17025:2017 - General requirements for the competence of testing and calibration laboratories
- Manufacturer's operation manual for the specific ozone detector model being calibrated
- Manufacturer's operation manual for the ozone generator and analyzer
- NIST - Certificates of Calibration for ozone generators and analyzers used in calibration

### 3. Definitions

- **Zero Calibration:** The process of setting the ozone detector to read zero in an environment free of ozone.
- **Span Calibration:** The process of calibrating the ozone detector to a known concentration of ozone.
- **Ozone Generator:** A device that produces controlled concentrations of ozone for calibration purposes.
- **Ozone Analyzer:** A device that measures ozone concentration, typically using UV absorption principles.
- **Transfer Standard:** A device that has been calibrated against a NIST-traceable ozone standard.
- **LPM:** Liters Per Minute, a unit of flow rate.

- **ppm:** Parts Per Million, a unit of concentration.
- **%vol:** percentage of volume, a unit of concentration.

## **4. Responsibilities**

### **4.1 Calibration Technician**

- Perform calibrations according to this SOP
- Document all calibration activities
- Verify that all equipment is functioning properly
- Report any anomalies or issues encountered during calibration

### **4.2 Quality Manager**

- Ensure that this SOP is implemented correctly
- Review calibration records
- Approve any deviations from this SOP
- Ensure traceability of reference standards
- Ensure that ozone generators and analyzers maintain their NIST-traceable calibration

## **5. Equipment and Materials**

### **5.1 Equipment**

- Ozone detector/analyzer to be calibrated
- Ozone NIST-traceable standard such as a:
  - NIST-traceable calibrated ozone generator, or
  - NIST-traceable calibrated ozone analyzer
- Calibration cap (as required per ozone detector model)
- Air Flow Meter that reads between 0.5 to 1.5 LPM
- Timer or stopwatch
- Thermometer, humidity meter and barometer for recording environmental conditions

### **5.2 Materials**

- Fresh air, zero air source (ozone scrubber or zero air generator) or nitrogen gas.
- Teflon or other ozone-compatible tubing for connections
- Connecting tubing compatible with the calibration setup

### **5.3 Verification of Calibration Equipment**

- The ozone generator or ozone analyzer must be calibrated against a NIST-traceable standard at least annually
- Maintain calibration certificates for all transfer standards and verification devices
- Perform intermediate checks of ozone generator output using a calibrated ozone analyzer

## **6. Environmental Conditions**

### **6.1 Required Conditions**

- Temperature: 20°C ± 5°C (68°F ± 9°F)
- Relative Humidity: 40% to 60%

### **6.2 Documentation**

Record the environmental conditions at the beginning and end of each calibration procedure. If conditions fall outside the specified ranges, document this as a deviation and assess the impact on calibration results.

## **7. Calibration Procedure**

### **7.1 Pre-Calibration Checks**

1. Verify that the ozone detector is in good working condition with no physical damage.
2. Check battery level to ensure adequate power for calibration.
3. Inspect all calibration equipment, including tubing and all connections.
4. Record the serial numbers of the ozone detector, ozone generator and/or analyzer.
5. Record environmental conditions.
6. Allow all ozone generators and analyzers to warm up for at least 30 minutes.

### **7.2 Zero Calibration Procedure**

1. Power on the ozone detector and allow at least 2 minutes for stabilization in fresh air.
2. If using fresh air for zero calibration: a. Ensure the calibration area is free from ozone contamination. b. Allow the detector to stabilize in fresh air for at least 2 minutes.
3. If using zero air for calibration: a. Connect the zero air source to the ozone detector using the appropriate calibration cap. b. Set the flow rate between 0.5 to 1.5 LPM. c. Allow zero air to flow for at least 2 minutes.
4. The ozone detector reading may not read precisely 0 ppm. Depending on the model, it may display 0.0 or 0.00 ppm.
5. Save the zero calibration point to the detector per the ozone detector model instructions.
6. Verify that the real-time display reading shows 0 ppm (or 0.0/0.00 ppm according to the detector's display precision or scale).
7. Record the pre- and post-calibration zero readings.

### **7.3 Span Calibration Procedure**

1. Ensure that zero calibration has been completed successfully before proceeding.
2. Configure the ozone generator to produce the desired calibration concentration. Typical calibration points include ranges from 1 to 20 ppm.
3. Verify the output of the ozone generator using a calibrated ozone analyzer.



4. Connect the ozone generator output to the detector using an appropriate calibration cap or equivalent.
5. Using the air flow meter confirm ozone gas is being delivered between 0.5 to 1.5 LPM.
6. Expose the ozone detector to the generated ozone for 2 minutes or until the reading has stabilized. Document any deviation from the standard exposure time.
7. Verify that the displayed ozone value has stabilized.
8. Save this span calibration point to the ozone detector per instructions of the ozone detector model.
9. Record the following:
  - Pre-calibration reading (before adjusting)
  - Span Gas Ozone Concentration (obtained from the Ozone Analyzer)
  - Post-calibration reading
10. Allow the detector to return to fresh air or zero air and verify that the reading returns to zero.

## **7.4 Calibration Verification**

1. After completing all calibration steps, verify the calibration by exposing the detector to the reference gas again.
2. Record the verification reading.
3. The reading should be within  $\pm 5\%$  of the reference ozone gas concentration
4. If verification fails, repeat the calibration procedure.

# **8. Documentation and Records**

## **8.1 Required Documentation**

For each calibration performed, record the following information:

1. Date and time of calibration
2. Calibration technician name
3. Ozone detector information:
  - Manufacturer and model
  - Serial number
4. Ozone generator/analyzer information:
  - Manufacturer and model
  - Serial number
  - Calibration certificate number
  - Calibration due date
5. Environmental conditions:
  - Temperature
  - Relative humidity
6. Calibration results:
  - Pre-calibration zero reading
  - Post-calibration zero reading
  - Generated ozone concentration as verified from ozone analyzer

- Pre-calibration span reading
- Post-calibration span reading
- 7. Any deviations from this SOP
- 8. Any observations or comments

## **8.2 Calibration Certificate**

Upon successful completion of calibration, issue a calibration certificate that includes:

1. Title: "Certificate of Calibration"
2. Laboratory name and address
3. Unique identification of the certificate
4. Customer name and address
5. Identification of the calibration method used
6. Description and identification of the ozone detector
7. Date of calibration
8. Calibration results
9. Environmental conditions
10. Signature of the person authorizing the certificate
11. Statement that results relate only to the items calibrated
12. Statement on measurement uncertainty
13. Reference to the traceability of measurements to NIST standards

## **9. Uncertainty Analysis**

Calculate and report the measurement uncertainty for each calibration according to the laboratory's uncertainty estimation procedure. The uncertainty is calculated as 95% confidence of the final calibration reading with a K factor equaling to 2. Items considered includes:

1. Ozone gas uncertainty (from Certificate of Calibration)
2. Environmental conditions
3. Equipment resolution
4. Repeatability
5. Detector Drift during Calibration
6. Effect of gas flow rate

## **10. Quality Control**

### **10.1 Regular Checks**

1. Perform regular checks of ozone generator output using a calibrated ozone analyzer.
2. Perform annual verification of transfer standards against a higher-level standard.
3. Perform regular quality control checks on calibration equipment (as required).

### **10.2 Non-conforming Work**

If any part of the calibration process does not conform to this SOP:

1. Document the non-conformance.
2. Evaluate the impact on calibration results.
3. Take corrective action as necessary.
4. Notify the customer if results are affected.

## 11. Revision History

Revision	Date	Description of Changes	Approved By
1.0	May 16, 2025	Initial Release	Quality Manager

## 12. Approvals

[illegible]

# APPENDIX 1

Example Certificate of Calibration - for a Single Ozone Gas Detector / Analyzer.



## Certificate of Calibration

**Customer Name:** Robert Olsen  
**Customer Address:** Incline, NV, 89451

**Calibration Location:**  
777 Silver Spur Road, Suite #130  
Rolling Hills Estates, CA, 90274, USA

**Test Conditions:** Temperature: 73F  $\pm$ 1%, Humidity: 59% RH  $\pm$ 1%

**Calibration Method ID:** SOP-CAL-002

**Certificate Number:** 33175-23060303

**Manufacturer:** Forensics Detectors

**Model Number:** FD-90A-O3-LOW

**Reference Gas(s):** OZONE (O3)

**Serial Number:** 23060303

**Reference Ozone** #042

**Last Calibrated:** 05/30/2025

**Analyzer Serial:**

### INSPECTION RESULTS

**Visual Inspection?** Normal, no anomalies

PASS

**Detector Functionality?** Normal, no anomalies

PASS

**Alarm Functionality?** Normal, no anomalies

PASS

### CALIBRATION TEST RESULTS

**Gas Name**

**O3**

**Reference Gas Concentration**

**1.0 ppm**

**Expanded Uncertainty  $\pm$ 5%**

(k=2, 95% confidence level)

$\pm$ 0.05 ppm

Pre Zero Calibration (As Found)

0.00 ppm

**Post Zero Calibration (As Left)**

**0.00 ppm**

Pre Span Calibration (As Found)

1.19 ppm

**Post Span Calibration (As Left)**

**1.00 ppm**

PASS

PASS

**Other Comments:** N/A

**Calibration Technician Name and Signature:**

Mr. Austin Jun

*Austin Jun*

**Date of Calibration:** 05/30/2025

**Certificate Issue Date:** 05/30/2025

**Next Cal Due Date:** 05/30/2026

The calibration results reported in this certificate relate only to the specific instrument / reference gas identified herein and are valid only for the conditions under which the calibration was performed. The reported expanded uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k=2, which for a normal distribution corresponds to a coverage probability of approximately 95%. All measurements performed during this calibration are traceable to the International System of Units (SI) through the National Institute of Standards and Technology (NIST). This certificate shall not be reproduced except in full, without written approval from Forensics Detectors.