

Inter-laboratory Comparison of Third-Party Certifiers and Subcontract Laboratories

Testing of Formaldehyde Emissions from
Composite Wood Products

2023

August 2024

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Summary

In the fall of 2023, California Air Resources Board (CARB) staff conducted an interlaboratory comparison (ILC) of CARB-approved third-party certifiers (TPCs) and their subcontract laboratories.

The primary objective of the 2023 ILC was to assess the proficiency of each laboratory to perform formaldehyde emissions testing of the selected test material, medium density fiberboard (MDF), according to the secondary method test¹.

Laboratory testing proficiency was assessed using two statistical measures, *Z-score* and *precision*. *Z-score* compares a laboratory's test result to the consensus mean of all test results, and *precision* evaluates a laboratory's measurement repeatability by calculating the difference between duplicate air samples.

A laboratory's testing proficiency was considered satisfactory if the following criteria were met:

- *Z-score* between -2.0 and +2.0.
- Precision \leq 0.02 parts per million (ppm).

Based on the criteria outlined above, all but one participant demonstrated satisfactory results.

I. Introduction

CARB's Airborne Toxic Control Measure (ATCM) to Reduce Formaldehyde Emissions from Composite Wood Products (title 17, California Code of Regulations, sections 93120-93120.12)² requires TPCs and their subcontract laboratories to participate in an ILC for formaldehyde emissions from composite wood products during the first year the laboratory is used by a TPC, followed by participation in an ILC every two years. Additionally, the United States Environmental Protection Agency (U.S. EPA) requires Toxic Substances Control Act (TSCA) Title VI TPC laboratories and their subcontract laboratories to participate in CARB's ILC or in a U.S. EPA recognized proficiency assessment, if available.

CARB previously conducted ILCs in 2009, 2011/2012, 2013, 2014/2015, 2016, and 2018/2019. Due to the pandemic, CARB was not able to organize an ILC between 2018 and 2022. In the fall of 2023, CARB staff initiated the 2023 ILC with assistance

¹ The secondary method test is defined as specified in ASTM D 6007 (ASTM, 2022), Standard Test Method for Determining Formaldehyde Concentrations in Air from Wood Products Using a Small-Scale Chamber, with additional conditions specified in section 93102.9(a)(2)(A) of the Airborne Toxic Control Measure (ATCM) to Reduce Formaldehyde Emissions from Composite Wood Products.

² *ATCM to Reduce Formaldehyde Emissions from Composite Wood Products*

from the Composite Panel Association (CPA, TPC-01). CPA purchased, prepared, and shipped the test material to each participant because CARB encountered problems purchasing the test material for the ILC.

II. Purpose

The purpose of the 2023 ILC is to:

- Evaluate the proficiency of each laboratory to perform formaldehyde emissions testing of composite wood products according to the secondary method test. Proficiency was evaluated using the statistical measures *Z-score* and *precision*, and
- Identify measurement issues and potential sources of error.

ILCs are also useful for monitoring laboratory performance over time. Laboratories can use the information from an ILC to improve and/or maintain internal operating procedures, instruments, and the analytical skills of laboratory staff.

III. Participants

Thirty-nine laboratories participated in the 2023 ILC. Participants included 35 CARB-approved TPCs and subcontract laboratories, two prospective subcontract laboratories, and two former subcontract laboratories. All CARB-approved TPCs were represented in the participating laboratories.

The names of the participants are listed in Appendix A. Although participant names have been provided in Appendix A, all information regarding test results and any follow-up evaluations have been kept confidential using codes. Only CARB staff and the respective laboratory know a laboratory's code.

IV. Study Design

Timeframe

The 2023 ILC was announced via email on August 18, 2023. On October 25, 2023, CARB sent participants an overview of the 2023 ILC, including the ILC test protocol and the data submittal form. CPA shipped the MDF test material to participants the week of October 30, 2023, and participants completed testing and submitted results to CARB between November 2023 and January 2024.

Test Material

TPCs and subcontract laboratories received nine pieces of MDF, each measuring approximately 18-inch (in) x 18-in, that were cut from evenly distributed portions across a single 48-in x 96-in panel.

Laboratories were responsible for cutting each piece of MDF to dimensions that are appropriate for their small chamber and consistent with the flow-to-area (Q/A) ratio specified in ASTM D 6007 (ASTM, 2022).

Shipping

CPA prepared and shipped test materials to participants. Prior to shipping via FedEx and DHL, the test material was cut, labeled, wrapped in thin plastic wrap, and placed in a shipping box.

Testing Protocol

The 2023 ILC test protocol, which is included in Appendix B and summarized below, directed laboratories to measure formaldehyde emissions from the MDF test material according to the secondary method test.

The ILC test protocol directed laboratories to:

- Condition the MDF within three weeks of receipt and begin testing within one week of conditioning to avoid potential decay in formaldehyde emissions,
- Condition the test material according to the period used to establish equivalence between their small chamber and a large chamber. Laboratories that had not conducted equivalence testing were instructed to use a 7-day conditioning period, consistent with the conditioning period for large chambers,
- Use the testing conditions and loading rates specified in ASTM D 6007 (ASTM, 2022),
- Conduct three small-chamber tests, testing the nine pieces of MDF in groups of three,
- Average the three test results to represent one data point for the test material, and
- Collect duplicate air samples (i.e., repeated measurements) for one of the three small-chamber tests.

Laboratories reported the test results and testing information, such as dates, temperature, relative humidity, and conditioning time, to CARB on the data submittal form, 'Data submittal form for ILC 2023.xlsx'.

CARB understands that some TPCs and subcontract laboratories only use a large chamber for certification testing and have not established equivalence between their small chamber and a large chamber. All CARB-approved TPCs and subcontract laboratories were encouraged to participate in the 2023 ILC, whether equivalence testing had been completed or not, to fulfill the requirement to participate in an ILC led by CARB or U.S. EPA.

V. Statistical Evaluation of the Results

Data Analysis

CARB staff reviewed each data submittal form for completeness and consistency, removing special characters from numeric fields and reformatting dates where needed. Additionally, test results were rounded to the nearest 0.01 ppm per ASTM D 6007 (ASTM, 2022).

The Tidyverse package (Wickham et al., 2023) in the statistical computing software, R (R Core Team, 2023), was used for calculations and to produce Figure 1.

Assigned Values

Assigned values are widely used for the purposes of calculating statistical scores (Thompson et al., 2006). They are derived directly from data sets and may serve as a reference for comparison. In this ILC, two assigned values were used: *consensus mean* and *acceptable standard deviation*.

Consensus Mean (\bar{X}): The assigned value for the consensus mean was achieved by calculating a mean of all reported test results. The consensus mean was rounded to the nearest 0.01 ppm per ASTM D 6007 (ASTM, 2022).

Acceptable Standard Deviation (σ): CARB assigned an acceptable standard deviation at ± 0.01 ppm. This value was based on the published precision of the large and small chamber methods (ASTM, 2022) for products that emit as low as 0.06 ppm.

Proficiency Assessment: Z-score

The statistical measure Z-score compares a laboratory's mean test result to the consensus mean using the acceptable standard deviation.

Z-score is interpreted based on the standard normal distribution ("bell curve"). Under this model, 95 percent of calculated Z-scores will fall within ± 2.0 standard deviations of the consensus mean. Z-scores in this range are commonly designated as acceptable or satisfactory (Thompson et al., 2006).

The Z-score for each laboratory was calculated according to the following equation:

$$Z_i = \frac{\bar{x}_i - \bar{X}}{\sigma}$$

where:

Z_i = Z-score of laboratory "i" for the respective MDF test material.

\bar{x}_i = reported formaldehyde concentration, in ppm, of the MDF test material, expressed as the mean of three test results, for laboratory "i".

\bar{X} = assigned consensus mean formaldehyde concentration, in ppm, for the MDF test material.

σ = assigned acceptable standard deviation (0.01 ppm).

Laboratory testing proficiency was evaluated according to the following criteria:

- $|Z| \leq 2.0$ Satisfactory
- $|Z| > 2.0$ Follow-up Evaluation Required

Proficiency Assessment: Precision

Measurement repeatability, or precision, was determined by calculating the concentration difference between duplicate air samples.

Precision was calculated for duplicate air samples according to the following equation:

$$precision_i = |x_i - d_i|$$

where:

$precision_i$ = precision, in ppm, of duplicate air samples for the respective MDF test material "i".

x_i = reported formaldehyde concentration in ppm for the respective MDF test material "i".

d_i = reported formaldehyde concentration in ppm of the duplicate air sample for the respective MDF test material "i".

Laboratories were considered for follow-up evaluation if the difference between duplicate air samples was more than 0.02 ppm. Duplicate air samples that differ by more than 0.02 ppm indicate imprecision in sample collection and/or analysis, instrument sensitivity, data reporting errors, or other issues.

VI. Results

Table 1 provides a summary of the reported mean results (\bar{x}), as well as the consensus mean (\bar{X}), acceptable standard deviation (σ), and range in calculated Z-scores (Z) and measurement repeatability (*precision*).

Table 1. Summary of Results

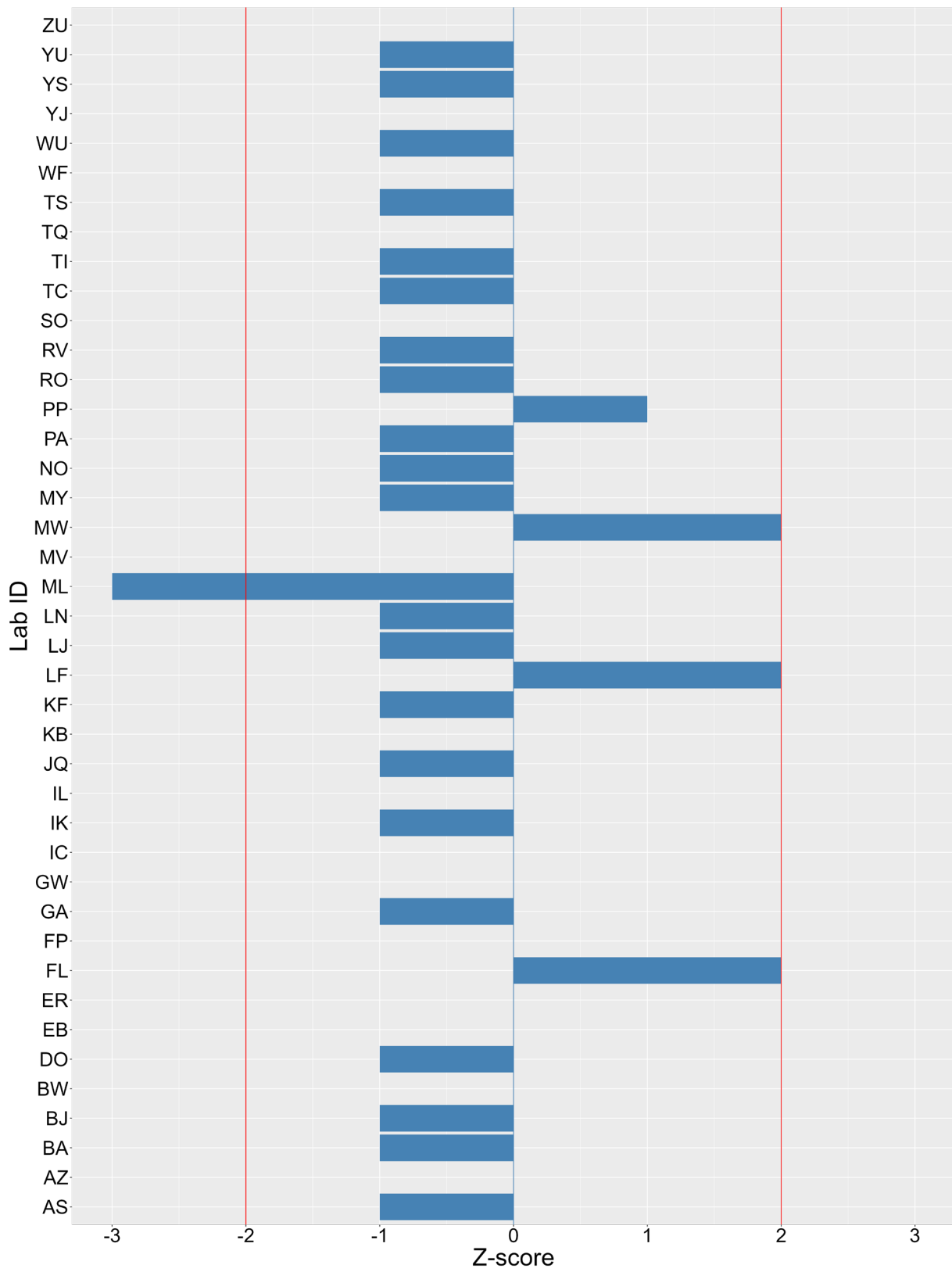
Parameter	Summary Statistic
Number of reported mean results (\bar{x}) ¹	41
Range in reported mean results (\bar{x})	0.01 – 0.06 ppm
Consensus Mean (\bar{X})	0.04 ppm
Acceptable Standard Deviation (σ)	± 0.01 ppm
Range in calculated Z-scores (Z)	-3.0 ≤ Z ≤ 2.0
Number of duplicate air samples ²	95
Measurement repeatability (<i>precision</i>)	≤ 0.02 ppm
Number of laboratories identified for follow-up	1

¹ Two laboratories provided test results for two small chambers. In both cases, a separate data submittal form was provided for each small chamber.

² Although the ILC protocol specified that laboratories should collect duplicate air samples for one of the three small-chamber tests, some laboratories collected duplicate air samples for all three small-chamber tests.

Figure 1 depicts the Z-score (Z) for each laboratory. Additionally, the reported mean result (\bar{x}), Z-score (Z), and *precision* for each laboratory are provided in Appendix C.

Figure 1. Laboratory Z-score (Z)



VII. Discussion

The 2023 ILC results showed minimal variability among the participating TPCs and subcontract laboratories. All participants showed proficiency in collecting duplicate air samples. All but one participant had satisfactory Z-scores.

Laboratories that received a Z-score of 0 had a mean test result equal to the consensus mean. Laboratories that received a Z-score of -1 had a mean test result 0.01 ppm less than the consensus mean, and laboratories that received a Z-score of 1 had a mean test result 0.01 ppm greater than the consensus mean. Laboratories that received a Z-score of 2 had a mean test result 0.02 ppm greater than the consensus mean. One laboratory received a Z-score of -3, indicating the mean test result was 0.03 ppm below the consensus mean.

CARB staff will follow up with the one laboratory that has a Z-score of -3 and with a few other laboratories where CARB staff have questions about the data submittal form. All follow-up is done to improve or verify understanding of the testing procedures.

VIII. References

American Society for Testing and Materials (ASTM), 2022. Designation E 1333 - Standard Test Method for Determining Formaldehyde Concentrations in Air and Emission Rates from Wood Products Using a Large Chamber. ASTM, West Conshohocken, PA.

ASTM, 2022. Designation D 6007 - Standard Test Method for Determining Formaldehyde Concentrations in Air from wood Products Using a Small Scale Chamber. ASTM, West Conshohocken, PA.

R Core Team, 2023. R: A Language and Environment for Statistical Computing. R Foundation for Statistical Computing, Vienna, Austria. <https://www.R-project.org/>.

Thompson, M., Ellison, S. L. R., & Wood, R., 2006. The International Harmonized Protocol for the Proficiency Testing of Analytical Chemistry Laboratories. *Pure Appl. Chem.*, 78(1), 145-196. doi: 10.1351/pac200678010145. Available at <https://old.iupac.org/publications/pac/2006/pdf/7801x0145.pdf>.

Wickham H, Averick M, Bryan J, Chang W, McGowan LD, François R, Grolemond G, Hayes A, Henry L, Hester J, Kuhn M, Pedersen TL, Miller E, Bache SM, Müller K, Ooms J, Robinson D, Seidel DP, Spinu V, Takahashi K, Vaughan D, Wilke C, Woo K, Yutani H (2019). "Welcome to the tidyverse." *Journal of Open Source Software*, 4(43), 1686. doi:10.21105/joss.01686 <https://doi.org/10.21105/joss.01686>

APPENDIX A - List of 2023 ILC Participants

Company Name	Country	TPC or Subcontract Lab (CL)
Composite Panel Association (CPA)	United States	TPC-1
Benchmark International (BMI)	United States	TPC-2
PFS TECO	United States	TPC-3
Fraunhofer Institute for Wood Research Wilhelm Klauditz Institute (WKI)	Germany	TPC-4
PT. Mutuagung Lestari Tbk. (MUTU)	Indonesia	TPC-6
PT. Mutuagung Lestari/Xuzhou MUTU Inspection and Testing Co., Ltd. (MUTU)	China	TPC-6
Capital Testing and Certification Services	United States	TPC-8
Entwicklungs- und Prüflabor Holztechnologie (EPH) GmbH	Germany	TPC-10
Research Institutes of Sweden (RISE)	Sweden	TPC-13
SGS Hong Kong, Ltd.	China	TPC-14
AIDIMME	Spain	TPC-15
CATAS SPA	Italy	TPC-16
FCBA	France	TPC-17
MPA Eberswalde Materialprüfanstalt Brandenburg GmbH	Germany	TPC-18
Łukasiewicz Research Network-Poznań Institute of Technology, Wood Technology Centre (LRNWTC)	Poland	TPC-19
Timber Research and Development Institute, Prague, s.e. (VVUD)	Czech Republic	TPC-23

Company Name	Country	TPC or Subcontract Lab (CL)
LAPI S.p.A.	Italy	TPC-24
WOOD.BE	Belgium	TPC-29
Intertek Testing Service Ltd., Shanghai	China	TPC-31
Intertek Testing Services Ltd., Hong Kong	China	TPC-32
Intertek Testing Service Ltd., Shenzhen	China	TPC-33
Cosmob S.p.A.	Italy	TPC-36
Ośrodek Badawczo Rozwojowy Przemysłu Płyt Drewnopochodnych sp. z o.o. (OBRPPD)	Poland	TPC-39
UL Environment	United States	TPC-42
UL Verification Services (Guangzhou) Co., Ltd.	China	TPC-42
SGS Vietnam Limited	Vietnam	TPC-45
Beijing Products Quality Supervision and Inspection Institute (BPOQSII)	China	CL to TPC-9, 37
Zhongbei Intl Testing & Calibration Co., Ltd.	China	CL to TPC-9
SGS Guangzhou Hardgoods Lab	China	CL to TPC-14, 45, 47, 48
SGS-CSTC Standards Technical Services Co., Ltd. Shanghai CCL	China	CL to TPC-14, 47
Forest Research Institute Malaysia (FRIM)	Malaysia	CL to TPC-37
Shanghai Hongjun Science & Technology Co., Ltd. (SHST)	China	CL to TPC-43, 44
TÜV Rheinland (Shenzhen) Co., Ltd.	China	CL to TPC-46
Guangzhou GRG Metrology & Test Co., Ltd.	China	CL to TPC-48

Company Name	Country	TPC or Subcontract Lab (CL)
CFT Corporation	China	CL to TPC-49, 50
Advanced Testing Services	United States	former CL
Berkeley Analytical Associates, LLC	United States	former CL
Intertek Testing Services Zhejiang Ltd.	China	prospective CL to TPC-31
Sustainable Stewardship Private Limited Universal Testing and Research Centre	India	prospective CL to TPC-37

APPENDIX B - Protocol for Inter-laboratory Comparison of Composite Wood Product Third-Party Certifiers and Subcontract Laboratories

The following protocol was sent to participants on October 25, 2023:

- 1. Summary:** The California Air Resources Board's (CARB) inter-laboratory comparison (ILC) of composite wood product third-party certifiers (TPCs) and their subcontract laboratories is scheduled for the fall of 2023.

Test materials will be prepared and shipped to participants by the Composite Panel Association (CPA). As we previously indicated, CPA will charge each participant a fee to cover the costs of preparation and shipping of the test material. CPA will send an email to each participant regarding payment of the fee. Please respond to CPA promptly. Participation in the ILC will be voided due to lack of payment.

Please be aware that participants will only receive test material to conduct secondary method testing (small chamber established as providing equivalent results to a large chamber). Even if a laboratory has not conducted equivalence testing, CARB wants all laboratories to participate using their small chambers.

Participation in the ILC will fulfill the requirement specified in Appendix 3 of the Airborne Toxic Control Measure (ATCM) to Reduce Formaldehyde Emissions from Composite Wood Products, title 17, California Code of Regulations, sections 93120-93120.12. Participation will also fulfill the requirement of U.S. EPA's Formaldehyde Standards for Composite Wood Products regulation (Toxic Substances Control Act, TSCA Title VI) that TPCs and their subcontract laboratories participate in an ILC led by either U.S. EPA or CARB.

Data from this ILC will be used to assess the testing capabilities of TPCs and their subcontract laboratories in CARB's on-going oversight of the TPCs.

- 2. Materials:** For the purposes of this ILC, medium density fiberboard (MDF) will be used as the test material. For ease of handling and to reduce shipping costs, each participant will receive nine pieces of MDF, cut from a single 48 inch x 96 inch panel of MDF. Each of the nine pieces will measure approximately 18 x 18 inches. Each piece of test material will be labeled by CPA with an alphanumeric code so that pieces from the same third of each panel can be identified. For example, for panel #10, three pieces will be labeled as 10a, three pieces will be labeled as 10b, and three pieces will be labeled as 10c.
- 3. Shipping and Handling of Test Material:** The test material will be wrapped in plastic wrap and shipped in a box. CARB will inform participating TPCs and subcontract laboratories by email once the test material has been scheduled to be

shipped. If you do not receive the test material within two weeks of the date it was shipped, please notify CARB staff.

Immediately upon receipt of the test material, a laboratory should store the wrapped test material in a room with controlled temperature and relative humidity. Do not store the test material in a freezer or in a hot warehouse, because these conditions could change the emission characteristics.

- 4. Schedule for Testing:** We would like all laboratories to initiate conditioning of the test material at about the same time. Shipping of the test material is scheduled for late October 2023. Conditioning should take place within three weeks of receiving the test material. Testing should commence the following week (see Table 1). We understand that the test material will arrive at the TPCs and subcontract laboratories at different times due to international shipping and shipping delays, so some flexibility is allowed.

Table 1: 2023 CARB Inter-laboratory Comparison Timeline (tentative)

Task	Responsible Party	Timeline*
Preparation of test material	CPA	October 2023
Shipment of test material to TPCs and Subcontract Laboratories	CPA	October 30, 2023
Test material conditioning	TPCs and Subcontract Laboratories	Mid - late November 2023
Emission testing		Late November - early December 2023
Report results to CARB		By end of December 2023
Data analysis	CARB Staff	January - February 2024
Release of results	CARB Staff	March - April 2024

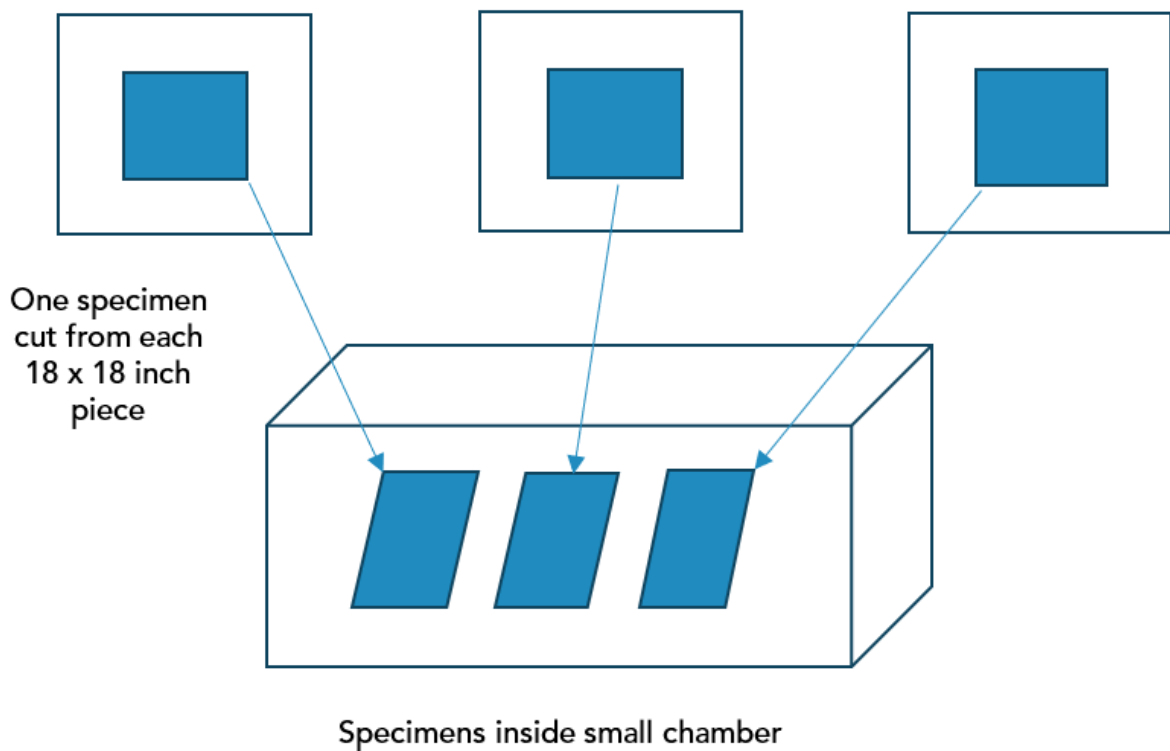
*The above dates may shift. Participants will be notified via email of any significant changes.

- 5. Secondary Method Testing:** Participants should follow their normal procedures for testing composite wood products, including the following steps:

- Conditioning should take place within three weeks of receiving the test material. The test material must be conditioned according to the period used to establish equivalence to the primary method. If a laboratory has not conducted equivalence testing, a 7-day conditioning period should be used, consistent with the conditioning period for large chambers.

- Each laboratory is responsible for preparing specimens of the test material to the appropriate dimensions to be consistent with the flow-to-area (Q/A) ratio for the test material and their small chamber, as specified in ASTM D 6007. Laboratories are responsible for cutting one specimen from each of the nine pieces, resulting in nine specimens.
- Testing should start within 1 week of conditioning. Three specimens should be tested simultaneously in one secondary method chamber as shown in Figure 1. The specimens should be positioned in the test chamber to allow the face and back of the test material to emit inside the chamber. Laboratories should follow their normal procedures for taping or sealing of edges of specimens.

Figure 1: Secondary Method Sampling



- Three small chamber tests will be needed to test all nine specimens. Testing can be conducted in three small chambers or all three tests can be conducted sequentially using the same small chamber.
- A duplicate air sample is required to be collected during one of the three small chamber tests. The duplicate air sample can be collected simultaneously or sequentially (i.e., two consecutive 30-minute sampling periods). Results of the duplicate air sample should be entered on the data submittal form (attached).
- Each laboratory must document the requirements of ASTM D 6007 and provide information about testing, summarized below regarding the data

submittal form. Please provide all information requested on the data submittal form.

- Do not discard the test specimens after testing. Immediately after testing, wrap the test specimens in plastic wrap and store them in an environmentally controlled room until CARB analyzes the data and the ILC is concluded. In some instances, CARB may request that a laboratory re-test or ship the test specimens to another testing location.

6. Data Submittal: All test results should be submitted to Hilary Minor at hilary.minor@arb.ca.gov using the attached Excel data submittal form, "*Data Submittal Form for ILC 2023.xlsx*." Please submit test results using our data submittal form in the Excel format. Please refer to the "Instructions" tab when filling out the data submittal form.

Each laboratory must document the requirements of ASTM D 6007 and provide information about testing on the data submittal form. On the data submittal form, please be sure to include:

- Laboratory information;
- Small chamber volume;
- Specimen dimensions and flow-to-area ratio;
- Analytical test method;
- Date conditioning started and conditioning duration (number of hours);
- Temperature, relative humidity, and background formaldehyde concentration inside conditioning area (chamber or room);
- Background formaldehyde concentration in empty small chamber;
- Date of testing and air sampling time (number of minutes);
- Temperature and relative humidity inside small chamber (during testing);
- Secondary method results (including duplicate results);
- Whether laboratory has conducted equivalence testing for small chamber; and
- Any significant event that might affect the results.

Please submit your results by the end of December 2023. Please inform CARB staff if you will not be able to meet this schedule.

For subcontract laboratories, in addition to providing test results to CARB, we request that test results be provided to the TPC(s) to whom they are under subcontract.

7. Results: CARB will summarize the results after receiving the data submittal forms from the participating laboratories. Laboratories will be assigned an anonymous identifier known only to CARB and the laboratory. CARB will release the results so that each laboratory can see how their results compared to other participants, without disclosing the names of the participants.

CARB staff intends to evaluate the formaldehyde emission testing proficiency of each TPC and subcontract laboratory in terms of z-scores that are based on a fitness-for-purpose criterion. This criterion is in accordance with the International Harmonized Protocol for the Proficiency Testing of Analytical Chemistry Laboratories (IUPAC Technical Report, Thompson, M., Ellison, S.L.R. and Wood, R., 2006, and The International Harmonized Protocol for the Proficiency Testing of Analytical Chemistry Laboratories, *Pure Appl. Chem.*, 78[1], 145-196).

For the purposes of the ILC, CARB staff will find a TPC/subcontract laboratory proficient when their z-score is within ± 2.0 of the overall mean. If the z-score is outside of the ± 2.0 range, the TPC/subcontract laboratory may be required to conduct follow-up testing and/or be required to evaluate their testing practices in an effort to improve their proficiency.

8. Contact Information: For questions about this ILC, please contact Lynn Baker at lynn.baker@arb.ca.gov or Hilary Minor at hilary.minor@arb.ca.gov.

9. Participating Laboratories:

- All CARB-approved Third-Party Certifiers
- All CARB-approved Subcontract Laboratories

10. Attachments

1. Data Submittal Form for ILC 2023.xlsx

Data Submittal Form for ILC 2023.xlsx

Please complete the 'Data Submittal Form' tab according to the following instructions:

1	Numerical data should be reported as a number. Do not include units or any other characters in the numerical data. For example, where background HCHO is less than the limit of quantification (LOQ), the LOQ should be reported. Do not include the "<" character in your response.
2	Please format all data in the specified units (where unit is specified). Dates should be reported as dd/mm/yyyy.
3	Use a decimal point (.) as a decimal separator in numerical answers. Do not use commas as decimal separators.
4	Only 1 duplicate test sample is required. For the tests without duplicate samples, please leave the "Duplicate" cell blank.
5	Please do not alter the format of the "Data Submittal Form" tab.
6	Submit this completed spreadsheet to hilary.minor@arb.ca.gov . A PDF version of this spreadsheet will not be accepted. If data integrity is a concern, please save your spreadsheet as "Read-only."

It is important that all participants follow these instructions so that the data is formatted consistently.

For questions, please contact Lynn Baker at lynn.baker@arb.ca.gov or Hilary Minor at hilary.minor@arb.ca.gov.

Parameter	Value	Unit
Laboratory Information		
TPC/Laboratory name		
TPC number (if applicable)		
Address		
Contact name		
Email address		
Date of data submittal form		dd/mm/yyyy
Chamber Information		
Small chamber volume		L (liters)
Has equivalence testing been conducted? (yes/no)		
Date of most recent equivalence testing		dd/mm/yyyy
Flow-to-area ratio		m/hr (meters/hour)
Analytical method		
Test Material Information		
Type of composite wood	MDF	
Date test material received		dd/mm/yyyy
CPA Label Number		
Specimen length		cm (centimeter)
Specimen width		cm
Total exposed area for three specimens in a small chamber test		m ² (square meters)
Conditioning Information		
Conditioning background HCHO		ppm (parts per million)
Date conditioning started		dd/mm/yyyy
Conditioning time		hours
Minimum temperature		°C
Maximum temperature		°C
Minimum relative humidity		%
Maximum relative humidity		%
Secondary Method Results - Test 1		
Testing background HCHO		ppm
Test date		dd/mm/yyyy
Minimum temperature		°C
Maximum temperature		°C
Minimum relative humidity		%
Maximum relative humidity		%
Air sampling rate		L/min (liters/minute)
Air sampling period		minutes
Test Result		ppm
Duplicate Result		ppm
Was background HCHO subtracted? (yes/no)		
Comments (issues that may affect results)		
Secondary Method Results - Test 2		
Testing background HCHO		ppm
Test date		dd/mm/yyyy
Minimum temperature		°C

Maximum temperature		°C
Minimum relative humidity		%
Maximum relative humidity		%
Air sampling rate		L/min
Air sampling period		minutes
Test Result		ppm
Duplicate Result		ppm
Was background HCHO subtracted? (yes/no)		
Comments (issues that may affect results)		
Secondary Method Results - Test 3		
Testing background HCHO		ppm
Test date		dd/mm/yyyy
Minimum temperature		°C
Maximum temperature		°C
Minimum relative humidity		%
Maximum relative humidity		%
Air sampling rate		L/min
Air sampling period		minutes
Test Result		ppm
Duplicate Result		ppm
Was background HCHO subtracted? (yes/no)		
Comments (issues that may affect results)		
Average of three small chamber tests		ppm

APPENDIX C - Laboratory Results

Lab ID	Mean Result (\bar{x}) (ppm) ¹	Z-score (Z)	Number of duplicate air samples	Laboratory precision (precision) ²
AS	0.03	-1	3	0.01
AZ	0.04	0	1	0.00
BA	0.03	-1	3	0.00
BJ	0.03	-1	3	0.00
BW	0.04	0	1	0.00
DO	0.03	-1	3	0.00
EB	0.04	0	1	0.00
ER	0.04	0	1	0.00
FL	0.06	2	1	0.02
FP	0.04	0	3	0.00
GA	0.03	-1	1	0.00
GW	0.04	0	1	0.00
IC	0.04	0	3	0.00
IK	0.03	-1	3	0.00
IL	0.04	0	3	0.01
JQ	0.03	-1	3	0.00
KB	0.04	0	3	0.00
KF	0.03	-1	3	0.01
LF	0.06	2	3	0.00

Lab ID	Mean Result (\bar{x}) (ppm) ¹	Z-score (Z)	Number of duplicate air samples	Laboratory precision (precision) ²
LJ	0.03	-1	1	0.00
LN	0.03	-1	3	0.00
ML	0.01	-3	1	0.00
MV	0.04	0	3	0.00
MW	0.06	2	3	0.00
MY	0.03	-1	3	0.01
NO	0.03	-1	1	0.00
PA	0.03	-1	3	0.00
PP	0.05	1	3	0.00
RO	0.03	-1	3	0.00
RV	0.03	-1	3	0.00
SO	0.04	0	1	0.00
TC	0.03	-1	3	0.00
TI	0.03	-1	3	0.00
TQ	0.04	0	3	0.00
TS	0.03	-1	3	0.01
WF	0.04	0	3	0.01
WU	0.03	-1	3	0.01
YJ	0.04	0	1	0.00
YS	0.03	-1	1	0.00

Lab ID	Mean Result (\bar{x}) (ppm) ¹	Z-score (Z)	Number of duplicate air samples	Laboratory precision (precision) ²
YU	0.03	-1	3	0.00
ZU	0.04	0	1	0.00

¹ Reported test results were averaged and rounded to the nearest 0.01 ppm per ASTM D 6007 (ASTM, 2022).

² Laboratory precision is the maximum calculated precision for laboratories that collected duplicate air samples for three small-chamber tests.